The Leitz-Lexicon

Edition 4

leitz

Ideas and innovation for your success

Good tools are the starting point for successfully transforming ideas into reality. True in the past, true today and will be even more so in the future. We all recall how proud we were when we held our first pocket knife in our hands; in cutting that first piece of wood we were sure that with our new skill, our new tool and vision we could conquer the world.

Leitz has produced woodworking tools for over 125 years. Our products are an essential part of the progresses that use this versatile and fascinating material whose natural qualities are yet to be fully utilised – wood.

Wood is the basic ingredient for the new composites that will open more new areas of application. And we take much pleasure in knowing our tooling developments are the stimulation for both technical and economical successful processing methods.

Leitz tools are recognised worldwide as the technological leader.
The new 4th edition of the Lexicon in front of you contains information on new concepts and new tools in an easy to follow layout. The first part details our extensive range of high-quality precision tools for processing solid wood, panel materials and composites. The second part discusses the many different applications in detail.

We have always seen the Leitz Lexicon not as a catalogue but as a reference manual to help you chose the right tool for the application. This is why when we published Edition 1 we decided to call it the Leitz Lexicon. With increasing competition worldwide we believe it is important for us not only to offer you our excellent products, but to give you the benefit of our experience to help you optimise your manufacturing processes.

So let's work together in the future for our joint success.

Yours

D. Brucklacher

Dr. Dieter Brucklacher
Managing Director of the Leitz group of companies.

Explanation of abbreviations

a_e	=	cutting thickness (radial)
a_p	=	cutting depth (axial)
ABM	=	dimension
AL	=	working length
ARS	=	no. of wiper teeth
ART	=	article
ART Nr.	=	article number
B	=	width
BDD	=	thickness of shoulder
BEZ	=	description
BO	=	bore diameter
$BO_{max.}$	=	max. bore diameter
CNC	=	Computer Numerical Control
D	=	cutting circle diameter
D0	=	zero diameter
DB	=	diameter of shoulder
DGL	=	number of links
DIK	=	thickness
DIN	=	German industry standard
DKN	=	double keyway
DP	=	diamond polycrystalline
DSC	=	shank diameter
DTK	=	reference diameter
Fabr. Masch	=	make of machine
FAW	=	bevel angle
FB	=	bevel width
FD	=	thickness of tongue
FL	=	length of tongue
FLD	=	flange diameter
Fr. Nr.	=	number of cutter
f_z	=	tooth pitch
f_{zeff}	=	effective tooth feed
GL	=	total length
H	=	height
HD	=	wood thickness (thickness of workpiece)
HL	=	high-alloyed tool steel
HS	=	high-speed steel (HSS)
HW	=	tungsten carbide
ID Nr.	=	ident number
ID Nr. LL	=	ident number left hand rotation
ID Nr. RL	=	ident number right hand rotation
IV	=	insulation glazing
KBZ	=	abbreviation
KLH	=	clamping height
KM	=	edge breakers
KN	=	keyway
KNB	=	keyway width
KNT	=	keyway depth (incl. bore)
L	=	length
LD	=	left hand twist
LEN	=	Leitz standard profiles
LL	=	left hand rotation
M	=	metric thread
MA	=	measure A
MB	=	measure B
MK	=	morse taper
m min^{-1}	=	metres per minute
m s^{-1}	=	metres per second
MU	=	width side relieve
n	=	RPM
$n_{max.}$	=	maximum permissible RPM
NAL	=	position of hub
NB	=	grooving width
ND	=	thickness of hub
NFL	=	grooving depth/length of tongue
NH	=	zero height
NL	=	cutting length
NLA	=	pinhole dimensions
NMR	=	grooving knife
Nr.	=	dimensions details (e.g. chuck, ball-bearing)
NT	=	grooving depth
OU	=	without side relieve
PB	=	profile width
PR. Nr.	=	profile number
PT	=	profile depth
PG	=	profile group
QAL	=	cutting edge quality
R	=	radius
RD	=	right hand twist
RL	=	right hand rotation
S	=	shank dimension
SB	=	cutting width
SLB	=	slotting width
SLL	=	slotting length
SLT	=	slotting depth
SP	=	tool steel
ST	=	stellite
STD	=	diameter of dowels
TD	=	diameter of tool body
TDI	=	thickness of tool
TG	=	pitch
U min^{-1}	=	revolutions per minute (RPM)
V	=	no. of spurs
v_c	=	cutting speed
v_f	=	feed speed
VE	=	packing unit
VSB	=	adjustment range
WZ Nr.	=	tool number
Z	=	no. of teeth
ZF	=	tooth shape (cutting edge shape)
ZL	=	finger length

Overview of tooth shapes

Square teeth regular shape (FZ)

Square teeth round shape (FZ)

Square teeth conical (KON/FZ)

Square teeth with chip thickness limitation (FZ)

One-sided bevel, positive hook (ES pos.)

One-sided bevel, negative hook (ES neg.)

Bevelled square teeth (FZ/FA)

Square/ trapezoidal teeth positive (FZ/TR pos.)

Square/ trapezoidal teeth negative (FZ/TR neg.)

Square/ trapezoidal teeth with irregular pitch (FZ/TR irr.)

Trapezoidal teeth positive (TR pos.)

Trapezoidal teeth negative (TR neg.)

Hollow tooth (HZ)

Hollow tooth with bevel (HZ/FA)

Hollow tooth/inverted V-teeth positive (HZ/DZ pos.)

Hollow tooth/inverted V-teeth negative (HZ/DZ neg.)

Alternate top bevel teeth positive (WZ pos.)

Alternate top bevel teeth with negative hook angle (WZ neg.)

Alternate top bevel teeth positive with normal teeth back and chip thickness limitation (WZ pos.)

Alternate top bevel teeth with bevel (WZ/FA)

Alternate top bevel teeth conical (KON/WZ)

Alternate top bevel teeth with irregular pitch (WZ irr.)

Square teeth with deep tooth projection (FZ)

Combinations of tooth forms ri/le/ri/le/square

Explanation of pictograms

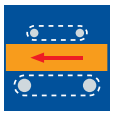
Sawing along grain

Scoring on top, on bottom

Grooving guiding groove

Jointing bevelling profiling

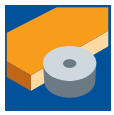
Grooving horizontal, vertical


Mech. feed

Noise reduced

Sawing thin kerf

Hogging


Jointing

Plunging

Copy-shaping grooving

Manual feed

Optimized chip flow

Sawing horizontal

Hogging along grain

Copy shaping

Through-hole boring

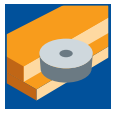
Jointing

Solid/ regrindable one-part tool

SP
Alloyed tool steel

Sawing single

Hogging across grain


Rebating

Counter-sinking

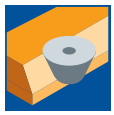
Rebating

Tipped tool regrindable

HL
High-alloy tool steel

Sawing from top solid wood

Hogging folding


Bevelling

Step drilling

Bevelling

Mech. edge clamping exchangeable

HS
High-speed steel

Sawing across grain trimming

Pre-planing horizontal

Bevelling rounding fluting

Slot mortising

Profiling

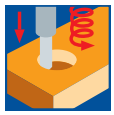
Mech. edge clamping reversable

Coated high-speed steel

Sawing multi pur-pose

Pre-planing vertical

Profiling


Excentric

Bevelling rounding fluting

Centrifugal edge clamping reversable

ST
Stellite

Scoring sawing

Finish planing horizontal

Profiling glue joint

Boring/ cutting

Finger jointing

Mech. edge clamping not regrindable

HW
Tungsten carbide

Sawing packs

Finish planing vertical

Profiling finger joint

Carving

Mitre jointing

Mech. edge clamping not read-justable

HWM
Tungsten carbide for metal pro-cessing

Sawing from top hollow profile

Planing profiling

Profiling mitre joint

Plug cutting

Counter-profile

Mech. edge clamping adjustable

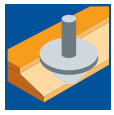
HWV
Tungsten carbide for solid wood processing

Sawing hollow profile

Grooving horizontal, vertical

Profiling counter-profiling

Interior cutting


Raised panels

Mech. edge clamping exchangeable and constant diameter

HWH
Tungsten carbide wood derived material processing

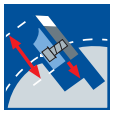
Scoring hogging

Grooving lamello

Profiling tongue/ groove

Exterior cutting roughing finishing

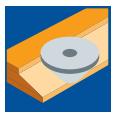
Mortising


Mech. edge clamping cassette system

DP
Poly-crystalline diamond (PCD)

Trimming

Finger jointing


Panel raising

Copy shaping

Centrifugal edge clamping reversable and regrindable

DM
Mono-crystalline diamond (MCD)

Guide for selection of cutting material

		Type of tool	Tipped tool					Tipped tool			Tool set				Single tool Tipped tool Tool set			
	Application		**Sawing**					**Hogging**			**Planing**				**Cutting**			
		Cutting material	ST	HWM	HWV	HWH	DP	HWV	HWH	DP	HL	HS	ST	HWV	SP	HL	HS	ST
	Workpiece material	**Type**																
Solidwood	Softwood	dry			♦			♦	◇		◇	♦	◇		♦	♦	♦	◇
		wet	♦		♦						♦	♦	♦			♦	♦	♦
	Hardwood	dry			♦			♦	◇			◇	◇	♦			♦	◇
		wet	♦		♦							♦	♦				◇	♦
Panels	Glulam				◇	♦		♦	◇			◇		♦		♦	♦	
	(plywood etc.)				◇	♦		♦	◇			◇		♦		♦	♦	
	Particle board	without coating				♦	◇		♦	♦								
	(Chipboard)	veneered				♦			♦	♦								
		melamine coating				♦	◇		♦	♦								
		paper coating				♦			♦									
	Fibre board	without coating				♦	♦		♦	♦								
	(MDF)	veneered				♦			♦	♦								
		melamine coating				♦	♦		♦	♦								
		paper coating				♦			♦									
	Hardboard					♦			♦	♦								
	Softboard					♦		♦	◇									
	High pressure Laminate (HPL)					◇	♦		◇	♦								
Plastics	Duro plastic (Pertinax…)					◇	♦		◇	♦								
	Thermo plastic (PA, PE, PP…)					♦			◇									
	Fibre reinforced (GFK, CFK…)					◇	♦			♦								
	Polymer compound (Corian…)					♦	♦											
Composite materials	Solid wood with HF, MDF…					♦	◇		♦	◇								
	Panels coated with HPL, Kork…					♦	◇		♦									
	Plaster board					♦			♦	♦								
	Cement board					♦	♦		♦	♦								
	Mineral wool					♦												
	Composite with light metal coating					♦		♦										
	Composite with steel coating			♦														
Metal	Light metal	pure (99,5)			♦												♦	
		alloyed			♦												♦	
	Lead alloy				♦												♦	
	Copper, zinc, brass				♦												♦	

		Type of tool	Single tool Tipped tool Tool set			Single tool Tipped tool Tool set							Single tool Tipped tool Tool set					
	Application		**Cutting**			**Routing**							**Drilling**					
		Cutting material	HWV	HWH	DP	SP	HL	HS	ST	HWV	HWH	DP	ST	HS	HWV	HWH	DP	
	Workpiece material	**Type**																
Solidwood	Softwood	dry	♦			♦	♦	♦	◇	♦			♦	♦	♦			
		wet					♦	♦	♦				◇	♦	♦			
	Hardwood	dry	♦					♦	◇	♦				♦	♦	♦		
		wet						♦	♦					♦	♦			
Panels	Glulam		♦	◇			♦	♦		♦	◇			♦	♦	◇		
	(plywood etc.)		♦	◇			♦	♦		♦	◇			♦	♦	◇		
	Particle board	without coating		♦	♦						♦	♦			◇	♦	♦	
	(Chipboard)	veneered		♦	♦						♦	♦			◇	♦		
		melamine coating		♦	♦						♦	♦			◇	♦	♦	
		paper coating		♦	♦						♦	♦			◇	♦		
	Fibre board	without coating		♦	♦						♦	♦			◇	♦	♦	
	(MDF)	veneered		♦	♦						♦	♦			◇	♦		
		melamine coating		♦	♦						♦	♦			◇	♦	♦	
		paper coating		♦	♦						♦	♦			◇	♦		
	Hardboard			♦	♦						♦	♦			◇	♦	♦	
	Softboard		♦	♦				◇		♦	♦				♦	♦		
	High pressure Laminate (HPL)			◇	♦						◇	♦				♦	♦	
Plastics	Duro plastic (Pertinax…)			◇	♦						◇	♦			◇	♦	◇	
	Thermo plastic (PA, PE, PP…)		◇	♦						◇	♦				♦	♦		
	Fibre reinforced (GFK, CFK…)			◇	♦						◇	♦				♦	♦	
	Polymer compound (Corian…)		◇	♦	♦					◇	♦	♦			♦	♦	◇	
Composite materials	Solid wood with HF, MDF…		◇	♦	♦					◇	♦	♦			◇	♦	◇	
	Panels coated with HPL, Kork…			♦	♦						♦	♦				♦	◇	
	Plaster board		◇	♦	♦					◇	♦	♦			◇	♦		
	Cement board			♦	♦						♦	♦			◇	♦	◇	
	Mineral wool		◇	♦						◇	♦							
	Composite with light metal coating		♦	♦						♦	♦				♦			
	Composite with steel coating																	
Metal	Light metal	pure (99,5)	♦					♦		♦					♦	◇		
		alloyed	♦					♦		♦					♦	◇		
	Lead alloy		♦					♦		♦					♦	◇		
	Copper, zinc, brass		♦					♦		♦					♦	◇		

♦ Suitable ◇ Partly suitable

9. Services

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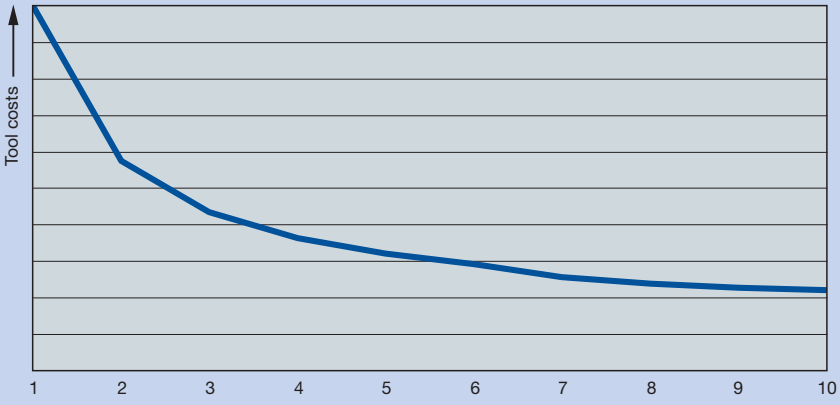
9.1 Sharpening of tools

Leitz Service station

A top quality tool only performs at its best, if serviced regularly by experts. It needs to be sharpened, repaired and returned quickly to the customer. For years Leitz, with a worldwide network of over 180 service stations staffed with skilled personnel has provided such a tool collection/delivery service.

Costs per life time of resharpenable tools



Tool economics increases with the number of sharpens. Also it is more economic to sharpen a tool frequently than to overrun the tool. Excessive use and wear can result in failure of the tool resulting in having to replace it with a new tool. In principle, it is possible to sharpen all cutting materials assuming the tool or cutter was designed to be sharpened. Leitz's years of experience as a tool manufacturer is evident in the quality of its sharpening, a sharpening quality which gives you a tool with 'as new' quality and performance.

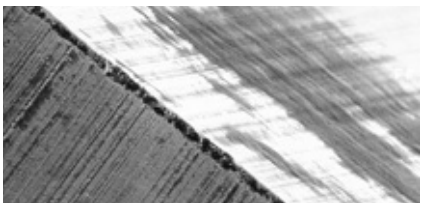
9.1 Sharpening of tools

Quality assurance

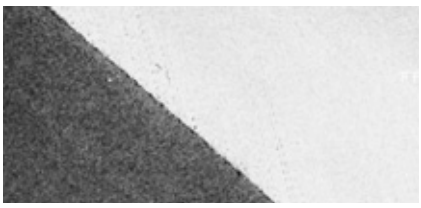
Quality is the focus of every Leitz service station. The DIN ISO 9000 certified quality system ensures one quality standard worldwide giving consistency and aiding your profitability.

As well as sharpening your tools, Leitz service stations can make minor repairs to the tools such as replacing damaged teeth.

Premium Service



HW-cutting edge standard cutting quality.



HW-cutting edge Leitz micro-finish.

Some Leitz service stations offer a premium service making handling your tools easier, boosting productivity and efficiency and giving you cost benefits. For example, tools can be mounted in their machine interfaces (e.g. an HSK 63 F chuck for a CNC-router) and sharpened in the interface. This significantly improves the concentricity giving a higher machined quality and a longer tool life.

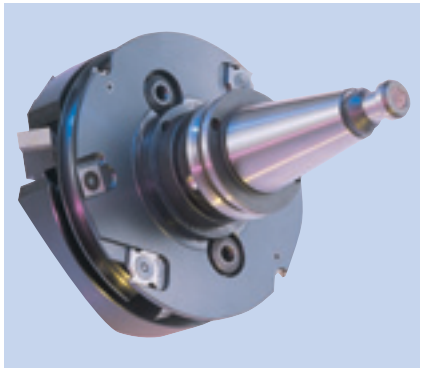
A polished finish is possible when sharpening sawblades or cutters, again improving the cut quality and tool life. However, polished edges are only beneficial when machining homogenous materials as contaminations can damage the cutting edge.

9.2 Tool measurement

Measuring stand

Costs – time and money – from test pieces and data input on CNC-machines are no longer a problem when the tools are measured prior to use and the setting data downloaded automatically to the NC-control. This saves up to 70 % of the set-up costs. Leitz-service is equipped with all necessary measuring and set-up equipment to give you with this service, a service to increase efficiency.

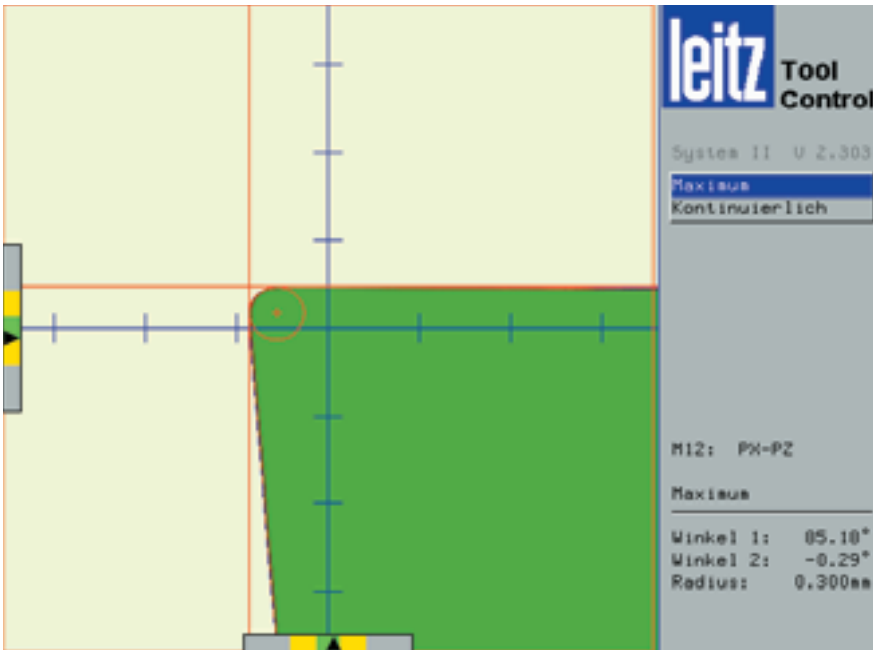
Chip coding



A microchip in the tool or in the tool interface is coded with all relevant tool geometry and operating parameters. The microchip is read automatically by the machine. Apart from reducing the set-up time and improving operating safety, this system allows you, when linked to a tool management system, to track and monitor the tool and help minimise your tool stock.

9.2 Tool measurement

Measurement by a projector



All machines, not only CNC's, benefit from pre-measured tools. Measuring, adjusting and pre-setting tooling sets quickly pays for itself. To rely on making test cuts, demount, clean, adjust and remount a tool involves significant set-up costs. Specific datum points are measured on the tool with a profile projector as required.

Chip coding-hardware

A 24 V-power pack, chip-code software and a PC work station are necessary.

Description	ID No.	
Data-transmission-package for Balluff Data chip, consisting of:		
Read-/write head, power pack		
and PC-connecting cable	**081305**	□
Balluff-casing	**081324**	□

Chip coding-software

For coding and reading different producers data chips

Description	ID No.	
Chip coding-software	**081351**	□

Connecting-cable

For direct transmission of measurements from Tool-Control to PC work station

Description	ID No.	
PC-connecting cable for Tool-Control ID No. 81401, 81420 as well as previous designs		
Tool-Control ID No. 81421, 81403, 81402, 81410, 81404, 81411	**081306**	□
PC-connecting cable for ID No. 81419 as well as 81425	**081328**	□

Data-chip-conversion

Description	ID No.	
SK 40 draw bolt with data chip Balluff	**081601**	□
Chip-mounting-unit Balluff for bores Ø 12 x 7 for HSK interfaces	**081309**	□

Mounting of chips by Leitz.

● available ex stock
□ available at short notice

Optical measuring and setting unit

Tool-Control

Type	Version	Spindle-clamping	D max.	L max.	ID No.	
1100	Projector Ø100	none	230	370	**081420**	□
2100	Camera	pneumatic	420	465	**081419**	□

Accessories

Tables and label printers

Description	ID No.	
Metal table for Tool-Control measuring equipment	**081488**	□
Stylus-label printer with cable for direct connection to all Tool-Control measuring and setting units	**081480**	□
Labels for stylus-printer	**081327**	●
Thermo-label printer with USB-cable and power unit for connection to Tool-Control measurement and setting units		
ID No. 81419, 81425	**081325**	□
Labels for Thermo-printer	**081326**	●

Adaptors

Description	ID No.	
Adaptor SK50/SK40	**081030**	●
Adaptor SK50/SK30	**081031**	●
Adaptor SK50/HSK-63 F	**081040**	●
Adaptor SK50/HSK-50 F	**081045**	●

Clamping arbors

Description	NL mm	ID No.	
Clamping SK50/Ø16	30	**081126**	
Clamping SK50/Ø30	50	**081038**	●
Clamping SK50/Ø35	50	**081047**	
Clamping SK50/Ø40	50	**081048**	●
Clamping SK50/Ø50	50	**081127**	●

Reducing sleeves

Description	NL mm	ID No.	
Reducing sleeve Ø20 to Ø16	20	**028314**	●
Reducing sleeve Ø35 to Ø30	20	**028291**	●
Reducing sleeve Ø60 to Ø50	20	**028315**	●
Reducing sleeve Ø80 to Ø50	20	**028316**	

Collet chuck

DL mm	Clamping range mm	ID No.	
Collet chuck SK50 with setting screw	2-25	**081033**	●
C spanner for collet nut		**005458**	●
Collets see collet chucks PM 350-0-05			

● available ex stock
□ available at short notice

9.3 Tool logistics

The right tool, the right quantity, the correct quality on time and on site – tasks to be monitored to keep your production running. These non-value-adding activities absorb time and resources, both of which would be better used on other activities.

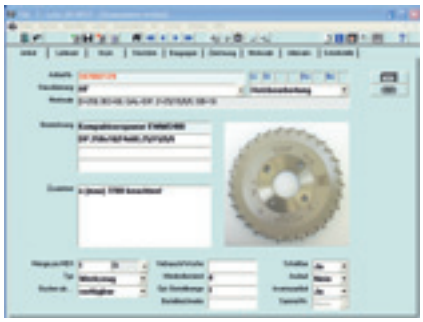
When it comes to supplying tools, Leitz has international experience and can give you a customised system. Whether a Kanbansystem, consignment stocks or complete care – our specialists can suggest a concept meeting your needs.

Leitz studies your current processes, quantifies the demand, both type and quantity of tools. Our specialists use this data to create a customised, technical and economic logistic concept. Leitz can also advise on storage systems, stock control systems and access authorisation.

Such systems have the following advantages, all can be measured financially:

- Stock reduction.
- Guaranteed tool availability.
- Correct tool for your requirements.
- Reduced downtime arising from missing tools.
- Payment related to tool usage.

9.4 Tool Information Management (TIM)



Tool Management Systems are complex and require professional control supported by special software. The Tool Information Management (TIM), software developed by Leitz, is an integrated component of any tool control system. TIM controls the tool database, records the condition and location of tools, checks tool availability, generates orders for sharpening and replacement, and can be used to relate the tooling costs to a product and/or machine. New dimensions can be transmitted by interfaces directly to the CNC-machines and data can be exchanged with the ERP-system.

Demand for tools and the money spend on tools are reduced as the tools are easy to locate and replacement tools are ordered on time through the automated systems.

Controlling the tool life and run time aids tool cost control and process cost calculations. TIM is the central link and database for all the items in the Tool Management System. Measurement equipment linked to TIM can supply the tool geometry data online and TIM can program a microchip embedded in the tool with its geometry and technical data. TIM can transmit the tool data directly to the machine control systems online by interfacing with a company's PPS system or via a pocket-PC of one of our service staff so ensuring up to date service and product data.

So controlling your tools with TIM helps you meet all the demands of a modern production plant.

Functions

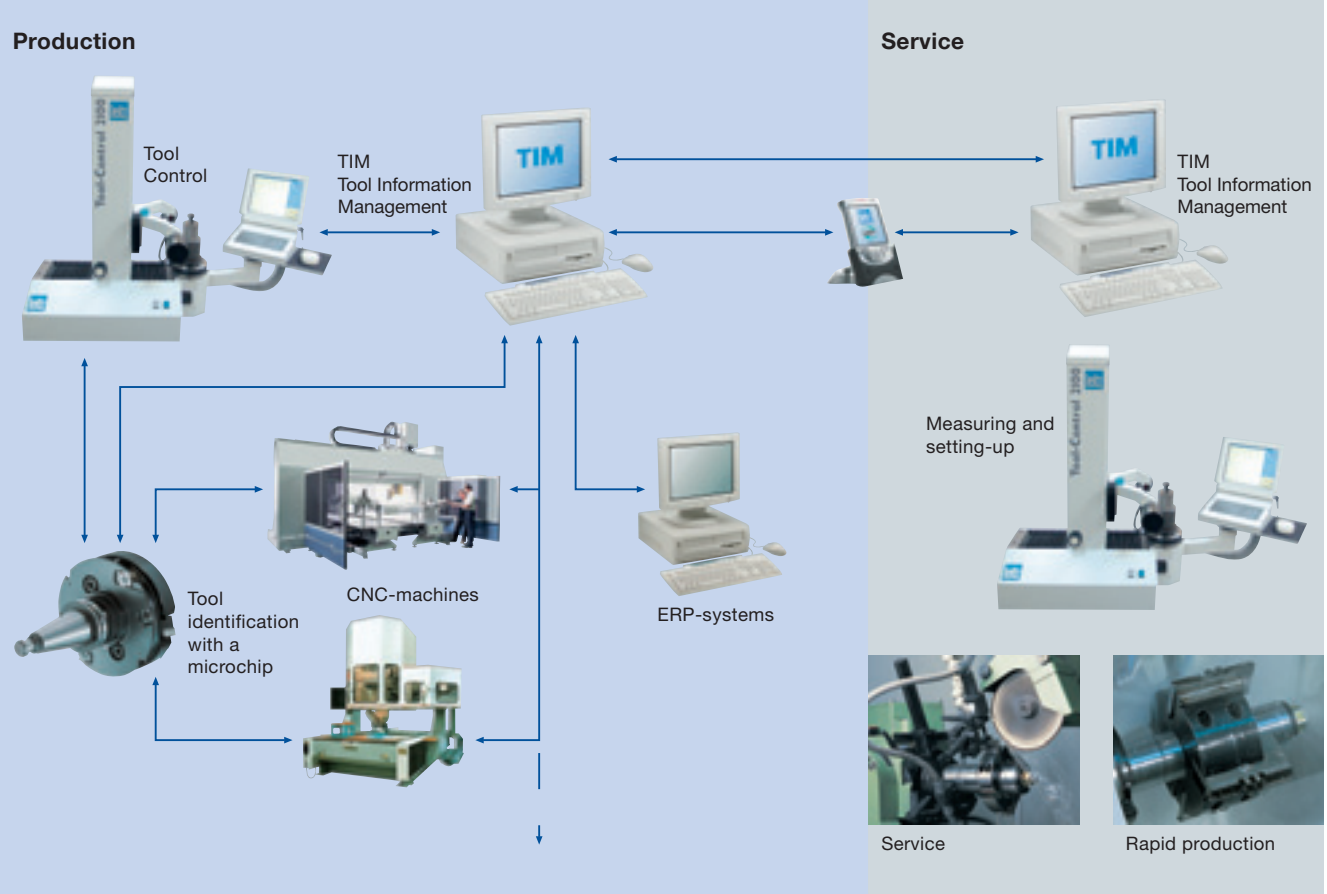
- Administration of tool data (description, drawings, characteristics).
- Condition of the tool, regrinding cycles, tool reference measurements.
- Tooling costs for products/machines.
- Disposition and ordering.
- Availability of the tools.
- Installation plans for machines, retooling lists.
- CNC-interfaces with correction-data transmission.
- ERP-system interfaces.

Advantages

- Easy location of tools.
- Automated ordering of tools.
- On time disposition of required tools.
- Reduced tool stock.
- Control over life time.
- Information of tool condition.
- Control of tool costs.
- Support for activity-based accounting.

Description	ID No.
Master database	**82000**
Ordering module	**82004**
Accounting module	**82003**
Service module	**82001**
Tool assembly	**82002**
Measuring equipment administration	**82005**
Stock module	**82006**
ORACLE Workgroup Server	**82007**
Initial installation	**82009**
Complete software package	**82011**
TIM Compact	On request
Standard module for SAP R3 connection	On request
Configuration for SAP R3 on site	On request
Additional licenses	**82008**

9.5 Complete Care



Complete Care – a package with precise costs so you can concentrate on your core business. We would like to show you Leitz's skill in optimising your processes. It's a fact, tooling costs account for less than 1% of your total costs, but not having the tools can have a dramatic impact on costs, and these costs are much higher than those of the tools alone.

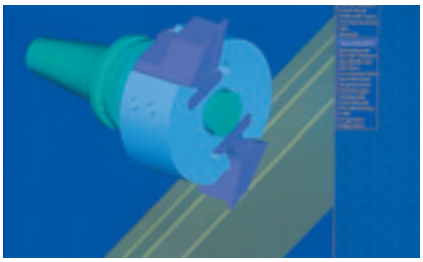
Leitz works with you developing a suitable Complete Care package. We take care of all your tooling needs; payment can be on an agreed basis.
– e.g. m^2, m^3, pieces of furniture or components.

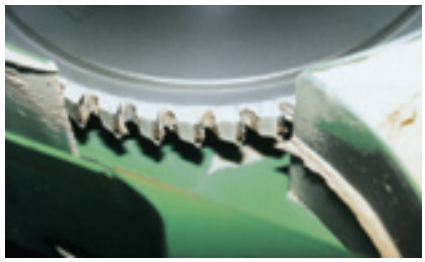
At the start of the program, process and costs analyses establish the starting point and current situation. From here we develop a customised concept outlining the potential for rationalisation, with payment related to the results.

Once the logistics are established, secure supply is established. Existing tools can be included in the overall concept. A Customer Care is not a short term project but a long-term partnership offering mutual benefits. Within the contract period a rationalisation program can be set up for an agreed price, so that you can calculate and plan for the future not only with fixed but with reducing costs.

Many customers worldwide already have positive experience with Complete Care, including some of the leading companies in the industry.

9.6 Technology & Process Consultancy





Daily our engineers and technicians are faced with varying production challenges. To help you meet these and be competitive in the future, we can show you how to optimise and achieve economic processing solutions. We offer you this service either on projects, specific applications or complete production processes. Of course at all times confidentiality is guaranteed, and the solutions are designed especially to meet your needs and requirements.

Leitz has the know-how. Our engineers' proposals can be charged on a time basis, or based on the cost and quality improvements.

We will also help raise your employees level of knowledge. Training and training workshops give you and your employees information on the latest developments in woodworking technology

Ask us for our support!

Introduction of innovative methods and tools.

Description	ID No.
Product workshop – window manufacturing	**82200**
Product workshop – parquet manufacturing	**82201**
Product workshop – furniture manufacturing	**82202**
Product workshop – woodworking	**82203**
Process workshop – window manufacturing	**82204**
Process workshop – parquet manufacturing	**82205**
Process workshop – furniture manufacturing	**82206**
Process workshop – woodworking	**82207**
Process optimisation – window manufacturing	**82208**
Process optimisation – parquet manufacturing	**82209**
Process optimisation – furniture manufacturing	**82210**
Extraching systems optimisation	**82211**

Charges exclude travelling and consultancy costs.

9.7 Training

Products and technologies are becoming ever more similar because of the nature of work. Developing competitive advantages today depends more and more on knowledge and motivated employees.
Even so high-tech tools will only perform at their best if used and set up correctly. Part of the Leitz-service program is educating and training customers and their employees, both in tooling and tooling applications. The training can either be at Leitz or in-house.
In addition to basic data on the technical, design and metallurgical characteristics of the tools, information is given on their suitability for specific applications. Information is also given on expected performance, comparison with other types of tools and cutting materials plus instruction on how to handle and maintain the tools. Many benefits come from the operator training program. It helps them control and monitor the process conditions and parameters, identify factors detrimental to performance and faults that may arise in the process.

Description	ID No.
Tool application – windows	**82100**
Tool application – parquet flooring	**82101**
Tool application – furniture	**82102**
Tool application – woodworking	**82103**
Tool handling – window	**82104**
Tool handling – parquet flooring	**82105**
Tool handling – furniturel	**82106**
Tool handling – woodworking	**82107**

Charges exclude travelling and consultancy costs.

9.8 Mounting and commissioning tools

There's a lot of work in commissioning a new production line – the investment has been made and you want the return on that investment as quickly as possible. The tools play a significant part in the success of the project.

Here Leitz-service can play a part. We will have already supported you when we designed the tools and when the product or production line was run for the first time. This way we ensure your performance expectations are achieved.

You deserve only the best.

Name	ID No.
Mounting and putting into operation	**82400**

Excluding travel expenses and charges.

10. Wigo in the Leitz-group

a member of the Leitz-group

For over 100 years Wigo has been synonymous for quality tools for both craft and industry. As a member of the Leitz Association, Wigo has the skill and experience to solve problems when machining plastic, mineral materials, non-ferrous metals and compound materials. Wigo, the specialist in these sectors, uses its knowledge and expertise in an ever-changing market to develop customer-specific tooling systems to meet the particular characteristics of these materials, and fine tune the tools and working parameters to suit. Close co-operation with the machine manufacturers, material producers and industrial processors ensure both the performance and economics of Wigo tools.

Another advantage is Wigo's close co-operation with Boehlerit, the Leitz-group cutting material manufacturer. The wide range of tungsten carbides and coatings currently available plus new developments give economic solutions.

Through the worldwide Leitz sales and service network, Wigo tools and this unique knowledge are available everywhere, with technical advisors to answer your questions. There is at least one Wigo product specialist in most Leitz subsidiaries.
For more complicated operations Wigo application engineering works directly with you to find the best solution.

Ranges of special tools are available ex-stock and Leitz-Service can maintenance and service your Wigo tools ensuring a long life of quality and performance.

User Manual

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Great tools – no compromises!

Selecting the right tool is all about making the best use of a productive machine's capacity. Product quality and economic operation are of the utmost importance. For the user the chosen tool system has to be as efficient and profitable as possible. Surely, then, the right tools should be given priority when making an investment?

Rational and profitable production and procedures are a pre-requisite to staying competitive. Cost pressure, customer needs, product requirements and new kinds of materials are on the increase – all these demand flexible and powerful processing techniques. Here the tools, rather than the machines, are asked to meet these criteria.

Leitz can look back on over 125 years of making tools – a period in which the company has firmly established itself as a first class producer. The expertise and experience means that Leitz can offer a high engineering standard benefiting its customers. Over 300 engineers and application technicians and 180 service centres around the globe look after customers' wishes on a daily basis. From dialogue with users and joint ventures with machine manufacturers, Leitz's modern technology centres in Germany and Austria seek solutions which are innovative, forwards thinking and above all meet our customers' requirements.

Leitz as a complete partner offers its customers a wide range of services ranging from advice on economic tooling solutions, advice on equipping processing machines to extensive engineering services. In this way production lines are configured, including specifying the machining technologies.

However, our development work also focuses on people. Their health, safety and working environment must be guaranteed, and these objectives must be met both by the Leitz tools and the machining processes.

In the Leitz Lexicon you will find an overview of tools, tool systems and performance data which will serve as a guideline. Should you have other questions or requests we will be happy to be of help.

We remain true to our motto "We shape the future"!

1.1 Tooling systems

Focus on people
Peoples' health, safety and working environment must be guaranteed, these objectives must be met by the Leitz tools and the machining processes. Leitz service staff, application technicians and engineers nurture close contact with customers, both in industry and craft. Factors, such as safety, noise reduction and lower dust emission are just as important to us as first class machining results.

Focus on tools
Great tools – no compromises A machine's productive capacity can only be optimised with the "right" tool. The expected product quality and economic operation have to be guaranteed. Leitz develops and produces efficient tooling systems to process all kinds of wood and plastic meeting these criteria.

Focus on materials
New processing concepts are required to meet changing customer tastes and new materials. Corundum coatings, polymer materials, acrylic and compound materials or minerals present the tool, and the machine, with a challenge. Leitz is constantly searching and developing solutions for cutting materials, tool designs and processing techniques to guarantee the user the best results.

Focus on machines
Leitz's services are needed where the machine and tool meet – high quality tools and systems which are safe, economic and environmentally friendly. Whether a hand-held circular saw, a CNC machining centre or a high-performance production line, the machine's productivity governed by the tool. So having great tools means no compromises!

1.1 Tooling systems

As a manufacture of all designs of tool, Leitz knows all tool constructions. The simplest construction is a one-piece tool, where the cutting edge and tool body are produced from a single piece of metal. This design is used for high-alloy (HL) profile heads and solid carbide shank tools. HL profile heads have, apart from a tough and strong cutting edge, a large regrinding area covering a large part of the tool body so making them economical.

But HL tools have a solid hardened steel body and as the body is hard and brittle it is sensitive to abrasive treatments (such as grinding or sand blasting). As HL tools also dislike three-dimensional stresses e.g. combinations of tension, twisting and bending, there is a risk of cracks.

The rigidity and so reduced vibration of solid carbide shank cutters means an excellent workpiece cut quality on solid timbers.

Tipped tools, where the cutting material is usually brazed to the tool body, are the most common tool construction. This group contains most types of sawblades, all tipped cutters, drills and hoggers. By combining several different materials on one tool, the tool can be optimised for the application.

The tool body has to be as cheap, rigid and as tough as possible, and the cutting edge should be hard and wear resistant. This construction makes economic sense if the cutting material is relatively expensive compared to the whole tool. As the cutting edge is brazed to the tool body there are few constraints to the design of the tool.

The most complex tool constructions are composite tools, for example cutterheads. Simply by changing the cutting edges the tool can be brought into “as new condition” time and time again. The mechanical forces on these tool designs need careful consideration because of the high RPM and feed speeds in woodworking.

With complex profiles, it is often better not to produce the whole profile with a single tool but to split the profile across several tool bodies and to assemble the bodies as a tooling set. The tool profile can be kept constant after each sharpen by adjusting the assembly. Typical of this design are profile/counter profile tools and tools for tongue and groove profiles.

Whether or not a tool can be sharpened is an important distinguishing feature and sets the economics for the tooling system. One has to distinguish between sharpening the cutter face and sharpening the cutting edge. Because of the cutting edge clearance angle, sharpening profile tools on the cutting edge, in most cases, alters the shape of the profile. Face sharpening has the benefit of being cheaper.

When sharpening sawblades, tests have proven it is better to sharpen both the face and the top as this combination removes the wear quickly and efficiently. Face sharpening along allows the saw plate to be retipped at the end of the saw tip life, but metal fatigue from the stresses from the repeated brazing cycle changes the characteristics of the saw plate; and so, for this reason, retipping is not recommended.

1.1 Tooling systems

Not all tools are resharpenable particularly those where the dimensions must remain constant. For example PCD tipped tools that are sharpened on the cutting edge but must have a constant diameter such as T-groove cutters. Sharpenable PCD tools are not recommended for applications needing constant diameters such as tools working with tracing wheels – trimming heads on double end tenoners. Constant diameter and sharpening the cutting edge do not work together, and it may be more economical to consider throwaway tools for these applications. Alternative designs may be possible for example splitting the tools into more than one part or to using cutterheads with replaceable cutting edges. These more complex tool designs have higher run-out tolerances arising from the assembly of the parts. Also there is a positioning tolerance of at least 0.03 mm when replacing a throwaway cutter.

Leitz ProFix cutter heads are an exception; whilst the ProFix knives are face sharpened the profile is guaranteed to remain constant. This is a feature of the design of the Profix constant profile/constant diameter tooling system.

Most tools have steel tool bodies and Leitz only uses top-quality accredited quality steels. Steel tool bodies are durable, rigid and resistant to wear. However large tools and tools for CNC machining centres may be too heavy if made of steel. In these cases the tool bodies are made of Aluminium and Leitz uses the high-strength aerospace specification alloys to guarantee their safety and resistance to wear. The ProfilCut replaceable knife clamping system is ideal for Aluminium bodied tools. Aluminium tools require special handling, details in the Leitz manual.

1.2 Economics in woodworking

We want to work with you to help you achieve the most economical manufacturing processes. The elements of productivity are as different as life itself. Certainly, the cost of the tool is a factor, but what benefit a cheap tool if it fails to reach the required quality standard or is unreliable. So it is important to define the costs for the process as a whole and not only to consider the purchase price of the tool.

Product quality is a basic condition for success and an important aspect of productivity. Also, it is possible to increase productivity by using better tooling to reduce the processing steps, eliminate rectification and reduce scrapped components. A second important aspect is improven economics through the tooling technology. Many projects in recent years have shown that there are several processes that do not fully realise the potential of machines. Simple four side moulders can run at a feed speed of 30 to 40 m/min. However, to achieve the desired high finish surface quality, the feed speed must be reduced to 10 to12 m/min on moulders with 6,000 RPM spindles (without the facility to joint) because of the single cutter finish. An alternative is the ProFix S-System; with Profix S the cutting edges can be set to a run out tolerance of less than 5 µm giving a multi-cut finish. So Profix S can give the machined quality on garden furniture and parts of multi-layer lacquer systems, at feed speeds between 30 to 40 m/min.

ProFix S

Using the TurboPlan planing system on high speed moulders can increase the feed speed from 130 m/min up to 200 m/min with consistent finish quality. The recently development in the knife clamping system means both the number of knives and the spindle RPM increased.

TurboPlan

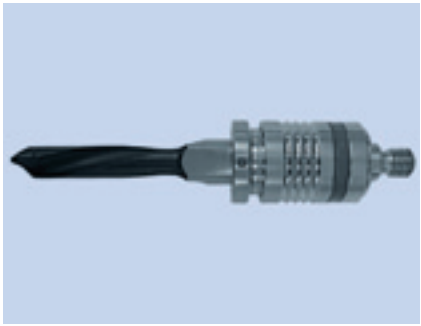
Productivity increase can also be by increasing the spindle RPM. By using 30,000 RPM spindles combined with suitable tools and tool clamping systems on CNC machining centres the time to produce a component can, in many cases, be reduced by 15-25 %. Despite slightly higher tooling costs it is possible to reduce unit cost of production by between 7 and 12 %.

Leitz reduces wood waste through thin-kerf saw blade technology. Ecology and economy – transferred to wood processing these two terms translate as “treating resources sparingly” and “economic processing”. For the user it means optimising wood utilisation and minimising waste. So positive benefits both in terms of product cost and the environment. To obtain maximum wood utilisation in all applications, Leitz supplies thin-kerf sawblades for machines with either one or more sawblades on one or more spindles, and very thin sawblades with cutting widths of 1,2 mm for stip production. An increase in the wood yield of up to 20 %.

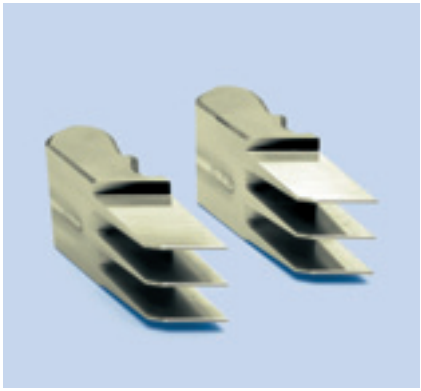
Thin kerf saw set

Another important target is to reduce non-productive time such as the set up time. Set up time has a major impact on total costs, both in mass production on high volume machinery and in one-off production. Leitz has developed various quick clamping systems to reduce the impact of set-up times. For example, set-up times for multi boring machines can be reduced by 80 % with the new drill quick clamping system.

1.2 Economics in woodworking



Drill quick clamping system.



Mini finger joint knives
with Marathon-coating.

Tool maintenance also plays an important role. The possibility of radial knife change without removing the cutterhead – as with Leitz ProfilCut tools – can have a significant influence on profitability on machines with stacked spindles. Additionally, the cutting edge run time needs to be considered as a separate issue from the tool purchase costs as this influences time lost in set ups. Leitz Marathon knives can tripe the tool run rime so save two setting-up times and money.

Apart from the direct costs associated with the tool – purchase, running, repair and maintenance costs – there are the hidden costs in administration and stocking which start at the purchase enquiry and finish in the accounts. All need to be considered for profitability. Leitz offers a range of services to allow you to concentrate on your core business and let you use Leitz to solve your machining and supply problems. Our technical consultants can tailor our offer to your personal requirements.

One thing is clear: More than ever before, priority must be given to customer-oriented services, as well as innovative high-tech products.
Leitz can supply all your needs, from process analysis, integrated manufacturing systems, supply and maintenance of systems to complete tool and resource management.

Leitz can give you the technical advice on efficient machining of the new generations of materials, and computer and Internet controlled tool management systems to give you the time to concentrate on your core business and to increase the profitability of your factories worldwide in the wood and plastic industries. This gives Leitz customers' the opportunity to be competitive in a world market.

1.3 Services

Increasing competition in the wood and plastic processing industries is forcing companies to rationalise. No business, irrespective of size, has the knowledge and ability to do everything.

It makes economic sense for a company to focus on its core business and strengths and to delegate the other tasks either before or during production to a service provider with direct industry experience.

Machinery and tooling manufacturers usually offer product support services. Leitz, since its beginning, has prided itself as a service provider and so a step ahead of the industry.

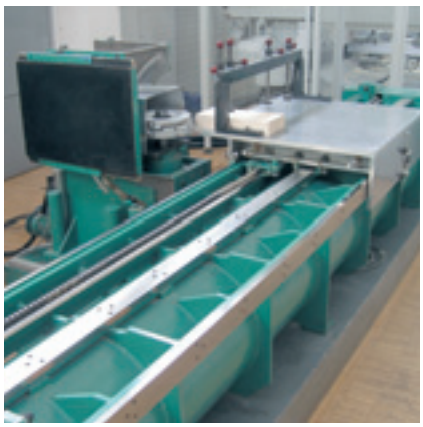
The service offered by Leitz comes from the knowledge and experience gathered over 125 years of researching, developing and testing tools. Cost reduction, using time effectively coupled with safety boost efficiency and help secure the future.

Use the range of services of offer from Leitz – either in total or part – that best suit your needs.

What's special about Leitz's services?
Leitz is a product-service provider. We offer our services as an integral part of our product range.

The wide range of Leitz tools is the foundation for our partnerships with companies, both small and large, in the wood and plastic industries.

The results show if a tool is good or bad. Producing good tools means understanding how they work. Developing and manufacturing market leading tooling systems for a world market implies the experience and knowledge to solve the problems that arise in demanding manufacturing processes.



The highest product quality is essential. Leitz has probably the best research and development facilities in the world, facilities supported by manufacturing and testing capabilities.

International presence and close co-operation with all the leading machinery manufacturers help Leitz identify early on future market tends and new manufacturing opportunities. Leitz's resources are there to work on the customers' problems and processes to provide practical oriented support services.

Leitz offers the broadest range of tools. The range covers all the processing steps needed in the technical and economic processing in the modern wood and plastic industries. Service problems can be solved objectively by considering the total process, not only the individual steps. Why not use these advantages?

1.3 Services

Also Leitz-service covers all the elements to successfully rationalise and optimise either a project or a large process; from analysis and expertise to complete Tool Process Management.

Leitz supports its partners both strategically and operationally with the objective to increase efficiencies – quality, productivity and process – and reduce costs, risk and scrap. The correct tool plays an important role, but the tool cannot be considered in isolation. The broad range of services on offer gives the user the competitive advantage to win market share through technology.

Leitz-service consists up of a number of modules and customers can chose one, more or all of the packages – to meet their requirements.

Overview of the Leitz-service
Planning and consulting covers all the tasks needed to organise a project. Leitz supports the project engineers meet their objectives by defining the approach and analysing the cost and time requirements. Preparating of accurate calculations and quotations before the start of the project leads to a smooth project implementation.

Process-engineering considers the production steps, environmental factors and associated activities. This covers the manufacturing steps, optimises the process, minimises the tools, considers the extraction system to minimise energy consumption, suggestions for noise reduction and help to develop the CNC-programs.

The benefits are reduced in processing costs, increased productivity, better use of resources and an improved working environment. These cover all the economic, strategic and operating factors that help plan production in the future.

Specialised Leitz technicians can advise on the **machine set up**, the **tool layout**, and the options. A machine layout plan detailing the tool positions reduces the risk of production errors, and close co-operation between the machine and tool manufacturers helps guarantee the performance and accuracy of the processing system. The first set up of the machine, tools and programs is not only to produce test pieces, optimise the set up, identify possible errors, refine the machining process and prepare the documentation but also to instruct the operators on how to handle and maintain the tools. The performance expected by customers is demonstrated in error-free operation of the machine and tools. The trained employees then take the responsibility for the tools and machine.

1.3 Services

Established processes can be replaced with new procedures when **purchasing tools.** The Leitz-service program offers an attractive customer-friendly solution – “one stop shopping”. This means passing the responsibility for the purchase and supply, either all or in part, to Leitz. Stock levels for high usage tools are set based on the tool life. Studying and optimising the purchasing procedure means ensuring it benefits from the latest technical innovations as well as the economic advantages of reduced administration costs and reduced investment in stock.

Another option is **guaranteed tooling costs** from Leitz. The cost of supplying the tools can be based on production – the quantity of workpieces manufactured in a set time period or, alternatively just on the number of workpieces. There are other possible payment options, on time alone or on the costs related to the quantity produced. The advantages of such cost structures are obvious as the costs are directly associated to the actual production quantity; another choice is the tooling cost can be paid in instalments over the life time of the tools. And of course the advantage is there are always sharp tools available.

Repeat and frequent demand for standard tools or consumable items can be covered by Leitz **vending-machines.** Once the tools and quantities required are established the machine can be stocked accordingly and re-stocked regularly by Leitz service-employees. Items are only dispensed by the machine to authorised company or Leitz personnel. This system makes it possible to ensure stock availability, to control the usage and costs efficiently and, at the same time, delegate the responsibility to others in the organisation.

Tool Management Systems are complex and require professional advise supported by special software. Leitz offers such an advanced up to date system. The **Tool Information Management** (TIM), software developed by Leitz, is an integrated component of any tool control system. TIM controls the tool database, records the condition and location of tools, checks tool availability, generates orders for sharpening and replacement. TIM can be used to relate the tooling costs to a product and/or machine. New dimensions can be transmitted by interfaces directly to the CNC-machines and data can be exchanged with the ERP-system.

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Maintenance of machines and tools is important if they are to maintain their true technical performance. A top quality tool only performs at its best if serviced by experts. Tools need to be sharpened and serviced on time to be ready for use at the customer.

Leitz has a worldwide tool service network with a collection/delivery service. Customers do not need to employ their own service personnel or bear the costs of shipping tools or sharpening. Customers have their sharpened tools returned, sharpened to the manufacturer's specification and with the quality of a new tool. Quality is paramount at all Leitz service stations. The quality management system certified to DIN ISO 9000 ensures worldwide consistent quality standards.

Apart from sharpening tools, Leitz service stations can also repair tools, for example replacing damaged teeth, refurbish throwaway-tip tools, set up tools accurately and recycle scrap tools.

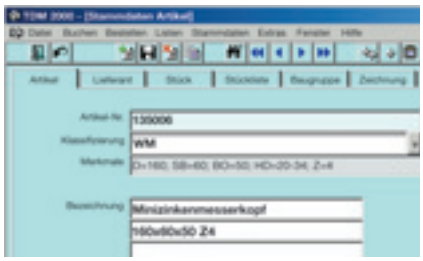
Products and technologies are becoming more similar because of the increasing nature of work. Developing competitive advantages is ever more dependent on the knowledge and motivation of employees. Even then high-tech tools only can perform at their best if they are used and set up correctly. An element of the Leitz service is to educate and train customers' employees on the types of tools and applications, and how to achieve cost and quality improvements.

Apart from the basic information on the design, construction and metallurgical characteristics of the tools, advise is given on their suitability for certain applications, their performance envelope, their performance compared to other tools, and instruction in handling the tools.

Operator training helps control and check the application and operating conditions, so they know what can influence or have a negative effect on the tools performance and can help them identify processing problems.

Cost reduction and quality improvement are achieved by developing concepts to reduce processing time, material costs and machine investment costs as well as improving product quality. Additional training can be arranged for Total Quality Management (TQM).

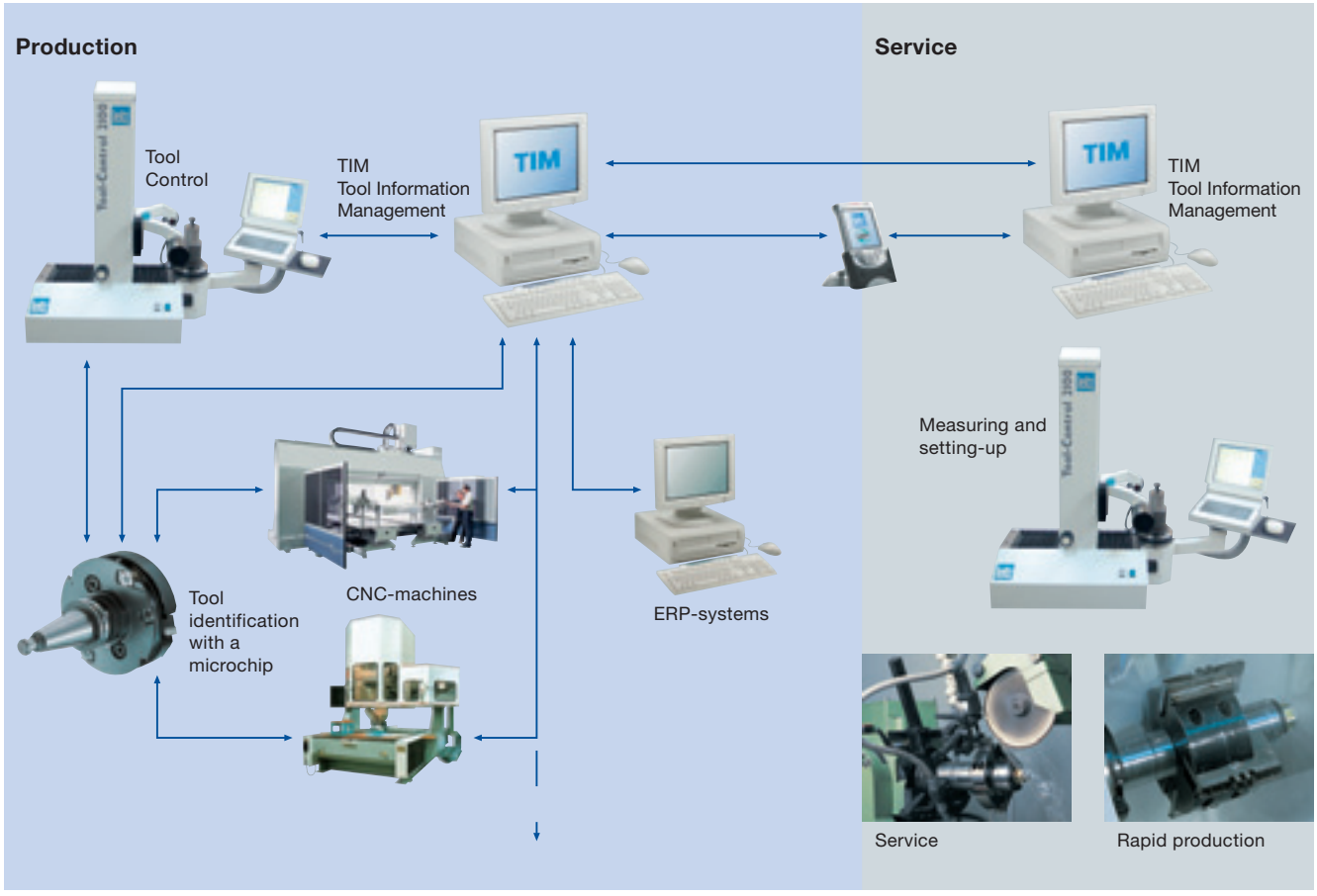
1.3 Services



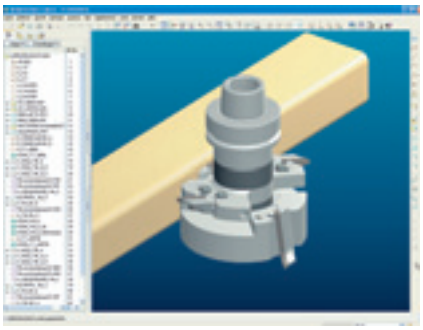
Informed, trained and motivated employees are a company's best resource to both save money and to use both top quality and up-to-date technology efficiently. Leitz helps you successfully meet this objective with its tools and services.

Tool Process-Management covers all aspects of tool usage and the process of planning, introducing and handling both complex and modular Tool-Management tasks based on specific customer's requirements. The Leitz-service modules cover all the areas in the process: using the different elements and controlling the tool logistics, both technical and economic, will help aid improve both production and quality standards across international production units.

Leitz has a close relationship with its customers and its markets, whether large or small. The success of its customers ensures the success of Leitz; for this reason Leitz concentrates not only on developing and manufacturing excellent tools for the future, but also on expanding its range of service and consultancy. Leitz is committed to use the experience and knowledge gathered over many years to help customers build on their success for the future.



1.4 Tool safety



Modern tool construction with 3D-CAD.

Labelling on planing head.

Labelling on Shank cutter showing minimum clamping length.

Centrifugal test rig.

Tools for woodworking machines are potentially dangerous to the user because of the high speeds and sharp cutting edges. Using machine guards and only using tools tested to meet the technical safety requirements reduces the risk of accidents.
Since the beginning, Leitz has considered safety as paramount when developing, designing and producing tools.

Safety at Leitz
The highest product safety is important to Leitz as a major tool manufacturer. All Leitz tools are manufactured to the EN 847 standards and constructed/produced considering the latest safety information. The basis for safe tools is set early in the development stages, evident from:

- Modern CAD techniques and calculation methods such as the Finite Element Method (FEM)
- Extensive testing including over-speed and reversing tests in the Leitz research department
- Tool certification to the BG tests as laid down by the Deutsche Holz-Berufsgenosssenschaft (German Wood Trade Association).

Manufacturing procedures, checked and documented to a certified quality management system DIN EN ISO 9001, guarantee the high, quality and safety standard expected of tools supplied by Leitz.
Support from Leitz – including local Leitz sharpening centres meeting the customers' needs and advice from technical specialists – ensures the safety of the tool over the life of the tool.

Safety in use
A tool is only as safe as how used by the operator. It is as important to have detailed and easily understandable instructions on the safe use of the tools as of their construction. Leitz played a part in the VDMA-project to develop templates for instruction handbooks for different types of tools. These layouts are used not only used for Leitz products but are also recommended by the European woodworking association EUMABOIS.

Users are advised of relevant safe handling information by the details etched on the tools, information such as the maximum RPM, method of feed, minimal clamping length for shank tools etc.

Intelligent tools with integrated memory chips are available for CNC machining centres. These tools automatically advise the machine control system of relevant geometry and technology data such as the tool length, tool diameter, recommended RPM, rotation etc. The risk of manual input errors is reduced giving high utilisation and safe use.

1.4 Tool safety

Intelligent CNC-tools.

ISO 3864 .S. ANSI Z535
VDMA Woodworking machines.

Safety Labels
Pictogram for machines operation, monitoring of operation and maintenance – woodworking machines.

Important note:
Tools and clamping systems are not subject to the machine guideline and therefore are not allowed to be marked with CE.

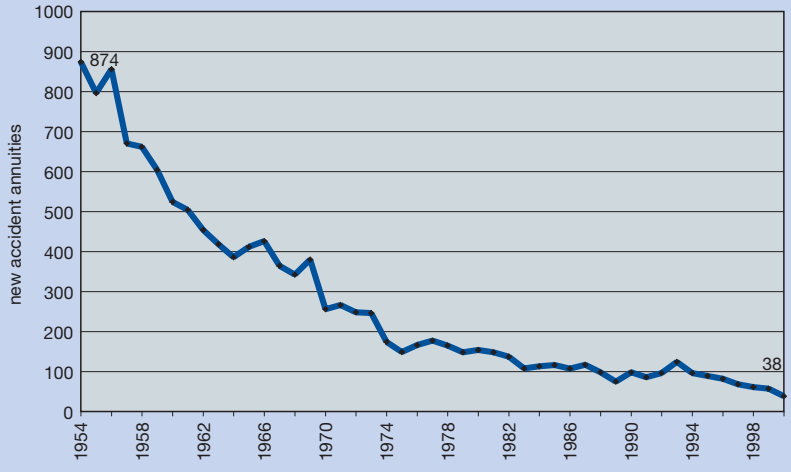
The comprehensive safety instructions supplied by the machine manufacturer should be followed when using the tools. The guards on the machine are to protect people and should not be modified or removed. Internationally accepted pictograms advise of any potential danger.

Safety guidelines
Leitz, and the other well known German tooling and machine manufacturers, form the Association of German Machine Manufacturers (VDMA). Leitz's years of experience is included in the national and international standards and regulations for safe construction of machine tools for woodworking and for operator safety around the world.

The series of European standards EN847, part 1 to 3 "Machine-tools for woodworking – safety requirements" form the guidelines for European tool manufacturers. These set the minimum standards for woodworking tools to make them be considered as safe.

An aim of the rules for manual feed tools is to reduce the kick-back.
The small gullet size and limited cutter edge projection lowers the severity of any injury – evident in the steady reduction in the number of accidents notified annually to the trade association.

EN 847-1	Machine tools for wood working – safety requirements Part 1: milling and planing tools, circular sawblades.
EN 847-2	Machine tools for wood working – safety requirements Part 2: requirements for shank milling tools.
EN 847-3	Machine tools for wood working – safety requirements Part 3: Clamping tools.



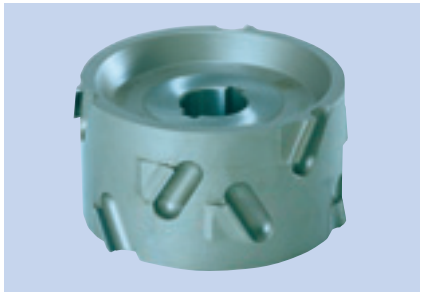
Steady reduction in the number of accidents annually (source: wood trade association).

1.5 Noise

Tyre profile with irregular pitched teeth.

UT-hogger with irregular pitched teeth.

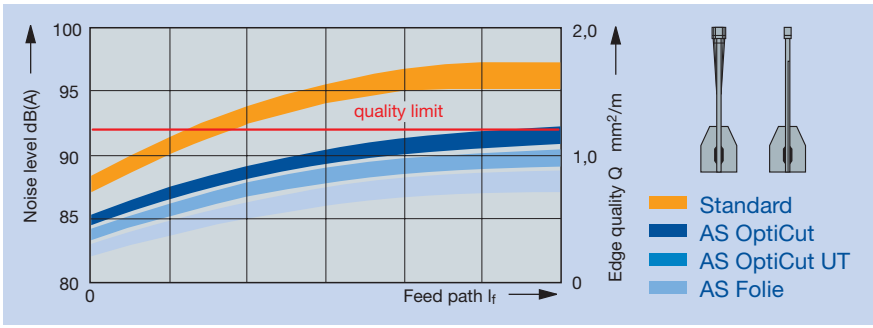
Conventional jointing cutter
94 dB (A).



Jointing cutter in
“low noise design” 86 dB (A).

Noise reduction in jointing cutting tools.

After dust, noise is a major problem in the woodworking industry.
It is important when developing new tools to reduce the noise levels at source and prevent them from increasing. If a noise level is lowered by 10 dB(A) the human ear perceives this as a 50 % reduction in noise.
The latest low noise tooling systems considerably improve the users’ working environment.



Axial vibrations of the body of plate-type tool such as a sawblade causes noise radiation. The vibration amplitude can be significantly reduced by the design of the teeth, by the design of the gullet geometry, and by damping the saw plate. Leitz offers a range of designs of low noise sawblades (AS) which take into account all the criteria, the machine and the materials to be cut.

A) AS sawblade with a foil (vibration damping through the friction between the sawblade and foil)
B) AS OptiCut-UT sawblade (irregular pitched teeth stop the harmonic vibrations within the sawblade)
C) AS OptiCut sawblade (laser ornaments in the sawblade body reduce the natural resonance and vibration by disturbing the sound waves).

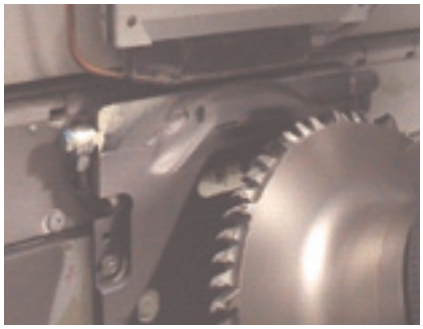
Air flow separation at the cutting edges is another cause of noise as this stimulates vibrations in the sawblade. The action of the cutting tips touching the workpiece also results in tool and workpiece vibrations.
Irregular distances between the successive cutting tips counteracts the harmonic vibrations and dampens both the free running and cutting noise. The principle of irregularly pitched teeth (UT) is successful both in saw-blades and profiling tools.

Work has also been carried out on ways to reduce the noise generated by cutting tools. A closed circular tool body shape, a profile that matches the tool body and optimised gullet geometry give a significant noise reduction. Today’s diamond jointing tools with these features generate half the noise of their predecessors.

But there are other – and appreciated – benefits from noise reduction. Reduced vibration means the tool runs quietly which in turn means a better cut quality and a longer tool life.

1.6 Chips and dust

Laminate flooring: Typical chip build up in a machine.



Problem: Wear from the abrasive chips.

Every woodworking production process causes chips that have to be extracted. As a rule the same amount of energy is required to collect and extract the chips as it takes to produce them. Despite state of the art extraction systems, not all the chips are collected. It does not matter whether you are processing solid wood or panels – uncollected chips have a negative impact on added value. They reduce the product quality, they make additional tool cleaning necessary, they increase the machine down-time or and can cause machine breakdowns through wear. Leitz's answer to this problem is DFC® (Dust Flow Control) tooling.

DFC®

The philosophy behind DFC® is to control the chips by using the kinetic energy in the chip flow to direct the chips away from the workpiece, away from the tool cutting edge and into the extraction system.

This improved method of chip collection has the following advantages:

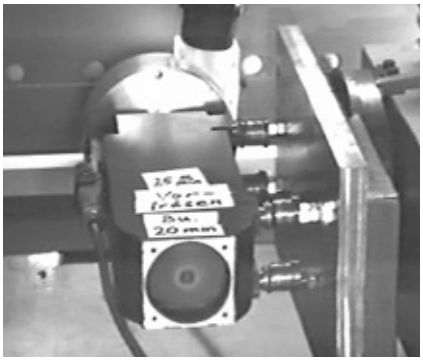
– Energy savings:
  The extraction airflow no longer has to capture the chips, only transport them into the extraction system. This reduces the required air volume flow and in winter saves on heating costs as the heated air is not being taken out of the factory.

– Improved product quality:
  Transporting systems are not impaired in any way by adherent chips or glue spillage.

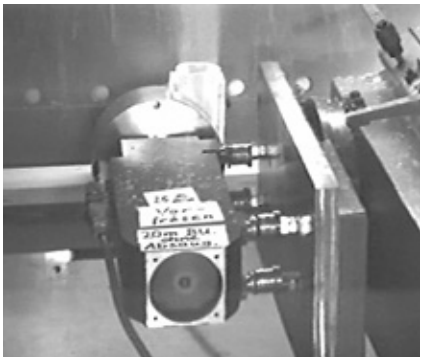
– Higher productivity:
  Clean machines means continuous production without stoppages.
  Clean workpieces do not need additional cleaning before packaging.

– Reduced servicing costs
  The abrasive chips are directed away from expensive machine elements releasing their energy against replaceable wear parts such as lead shoes, dust hoods or extraction pipes.

i-flooring: DFC®-tool and matched extraction hood. The largest part of chips is collected and wear is kept away of the machine.



i-system: Tool and extraction hood form a single unit. Over 95 % of the chips are collected – e.g. edge trimming.



Active chip collection: The chips are collected using their kinetic energy only. Example without extraction hood.

1.6 Chips and dust

Hogging veneered panels with overhanging veneer.

Broken off pieces of wood plug the extraction hood – fire risk through friction of the rotating tool!

DFC®-hogger with shredder cutting tips chop the coatings into easily extracted small pieces.

Application examples for DFC®-tools:
The DFC®-technology exists for hoggers, jointing cutters, profile cutters, grooving and shank tools and DFC is under continuous development.
The best results are achieved, when the tool and the extraction system are tuned to each other. Examples of such DFC-system solutions are:

– i-system

  Developed with the Lignum machinery group for efficient chip collection on edge banding machines – over 95 % efficient.

– DFC®-tools for laminate and parquet flooring production with matched extraction, e.g. “i-flooring”, significant reduction of wear to the machine guidance and feed systems from the abrasive chips.

DFC®-tools are important in hogging; the problem of continuous highvolume chip production cannot be solved simply by increasing the extraction velocity. It is necessary to direct the chips in the right direction at production. The effect cannot be seen so easily on, for example, CNC machining centres when sizing panel materials. Often compromises have to be made in the design of the tool with regard to the working method and chip flow. The chips can block the extraction hood – a fire risk from the friction from the rotating tool!

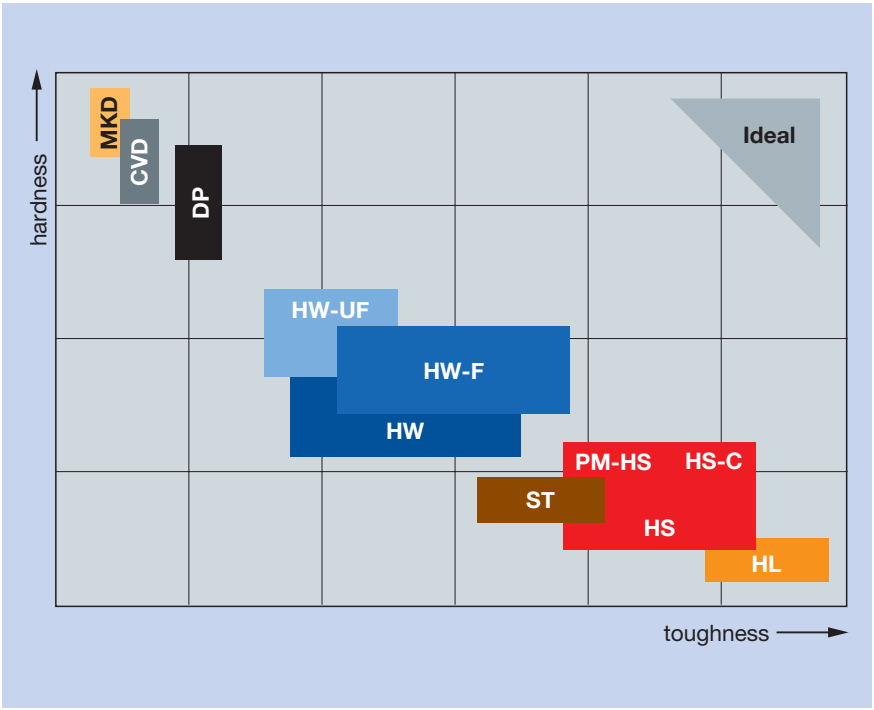
Chips can block the extraction pipes and stop production. Well known examples are machining veneered or laminated coated panels where the coating projects over the edge of the panel. Conventional tools do not break up the weak projecting coating. Long strips or chips of wood block the extraction. Such blockages can be the source of machine fires. DFC®-hoggers with shredder cutting tips solve the problem by breaking the projecting coatings into easily extracted small pieces.

Splitting a worktop with DP-routers. Conventional routers: Chip flow leaves horizontally and goes through the jigs and dust curtain.

DFC®-router: the chip flow is directed upwards into the extraction.

1.7 Cutting materials

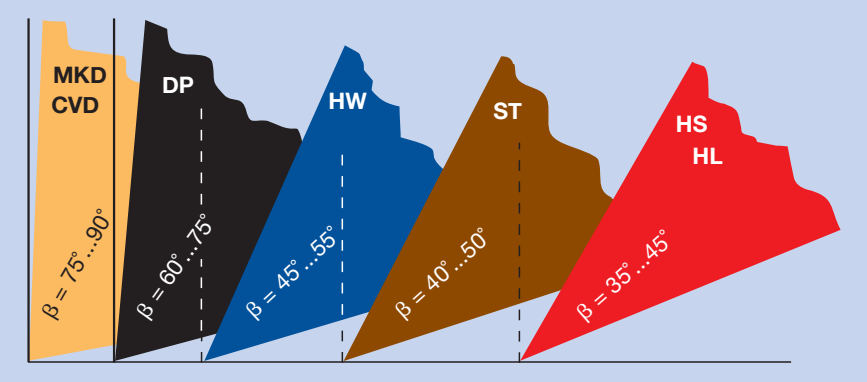
Profit is made at the cutting edge! Wear resistant cutting materials with sharp cutting edges guarantee long tool lives and high surface quality. But you can only exploit the potential of a cutting material if you have the correct cutting edge geometry; this in turn depends on the machining process and the properties of the material being shaped. Not an easy task – but not something to be afraid of, after all there are specialists at hand to help.



Cutting materials for processing wood and plastics
The ideal “cutting material” should be both hard and tough at the same time, but these “all-purpose materials” just do not exist. Today the choice of woodworking cutting materials ranges from tough tool steel to the hardest material in the world, diamond. The wide variety of materials and tool designs need all these cutting materials:

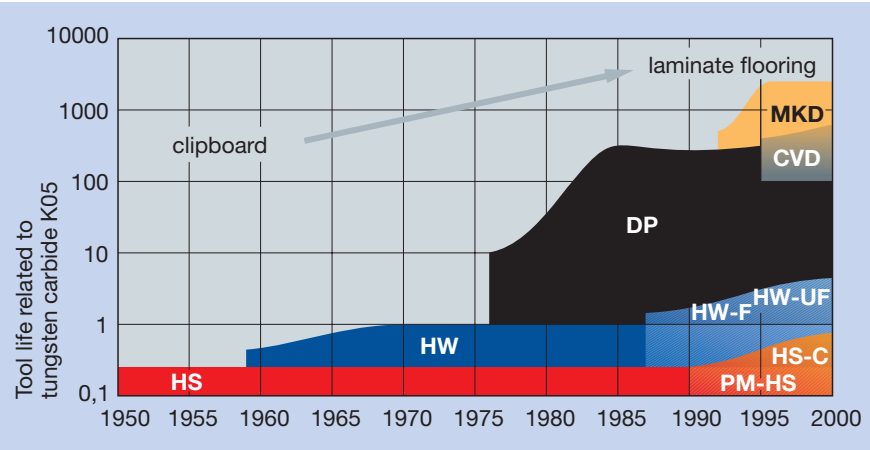
SP	Special steel, an alloyed tool steel for softwoods
HL	High-alloyed tool steel for softwoods
HS	High speed steel for soft and hardwoods
HS coated	Coated high speed steel for soft and hardwoods
ST	Stellites mainly for damp woods
HW	Tungsten carbides for softwood, hardwood and laminated timber as well as panel materials
DP	Polycrystalline diamond (PKD) for panel materials, reinforced plastics, Non-ferrous metals and hardwood
MKD	Monocrystalline diamond for highly abrasive materials such as flooring laminates or for a polished finish on plastics and nonferrous metals

1.7 Cutting materials



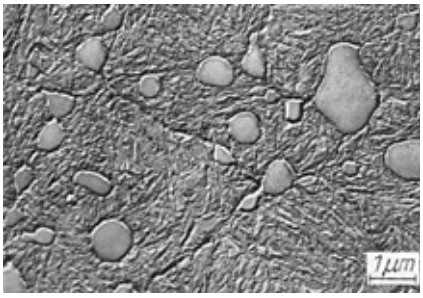
Cutting material specific geometry.

MKD- and HS-cutting edge in comparison of the wedge angles.



Tool life development from different cutting materials
All developments in cutting material aim for longer tool lives. Often new materials demand new cutting materials. Chipboard gave birth to tungsten carbide and later to polycrystalline diamond, laminate flooring to monocrystalline and CVD diamond and laminated woods to fine grain tungsten. In the 50 years since the development of panel materials, tool life has increased over a thousand times.

High-alloyed tool steel (HL) is the classic cutting material for softwoods, and frequently used for planing and profiling in the primary industries.



Structure of HS.

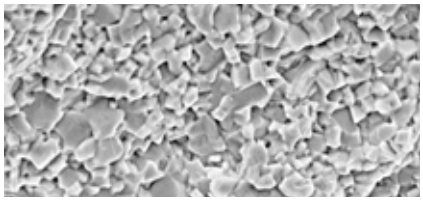
High speed steel (HS) is the traditional cutting material for solid wood. Here, as with tungsten, carbides in the alloy are responsible for the wear resistance and cutting strength. Vacuum hardening ensures the materials are heated gently in an eco-friendly way resulting in a good balance between hardness and cutting strength.

Coated high speed steel the “Marathon” coating by Leitz, is ideal for the machining solid wood. The high speed steel is coated with a ceramic to increase performance by reducing cutting edge wear and surface friction. The tool life can be increased up to 6 times compared with uncoated high speed steel. This performance continues even after sharpening.

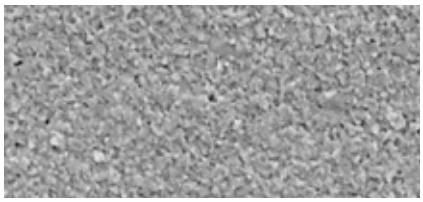
Stellite (ST) is a non-ferrous alloy of cobalt, tungsten and chromium manufactured in a melting process. Stellites are highly corrosion resistant and allow small wedge angles at the cutting edge. Typical applications are,

1.7 Cutting materials

Tungsten carbide sintering furnace.



Structure of standard tungsten carbide.



Structure of UF carbide.

MKD cutting edge.

Vacuum hardening furnace.

for example, processing fibrous or damp, acidic woods in sawmills or planing mills and machining Merranti, oak or poplar.

Tungsten carbides (HW) are sintered materials manufactured by pressing powder into moulds and “baking” under high pressure at high temperatures. Metal carbides, the major component, are responsible for the hardness, primarily tungsten carbide. Metals, commonly cobalt, are used as binders. The wear resistance and toughness can be varied across a wide range by the grain size and quantity of binder in the mix; today tungsten carbide cutting edges cover the widest range of woodworking applications from knotty softwood to Corian. Leitz has played a major role in this development. Boelherit, a tungsten carbide manufacturer and member of the Leitz group, constantly improves and develops tungsten carbides to meet the market requirements. Fine grain tungsten carbides with a micro polished finish are available to meet the greatest demands. These cutting edges with a very high initial sharpness are today replacing HS in woodworking. Ultra-fine grain tungsten carbides, with a low proportion of binders, have a very high hardness and are the latest development. These achieve 2 to 6 times increase in tool life in high wear materials such as MDF, chipboards, fibre chipboards or laminated timber with glue lines.

The diamond cutting materials used in woodworking are synthetic, and there are three basic types:

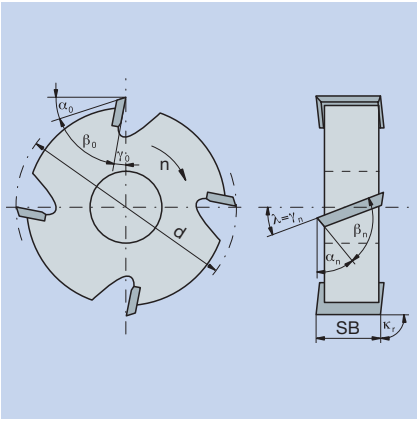
Polycrystalline diamond (DP) consists of diamond grains with a diameter of several microns – held together in part by inter grown grains and in part by a metallic binder matrix – sintered to a 0,5-0,7 mm thick tungsten carbide backing layer. The toughness and wear-resistance can be tuned for a wide range of applications by varying the grain size. Polycrystalline diamond has, for more than 20 years, proved its value when processing wood based materials, plastics and light alloys and is a technology no one can imagine being without.

Monocrystalline diamond (MKD) is a monocrystal of restricted size and is the hardest of all cutting materials giving it the highest resistance to abrasion. As there are no grain boundaries, extremely smooth and sharp cutting edges can be grounded. The high hardness is combined with brittleness so MKD edges must have high and stable cutting angles.
As a result MKD applications are limited, for example, to machining highly polished edges on plexiglass and non-ferrous metals or highly abrasive flooring laminates.

CVD diamond is deposited as a result of a coating process (Chemical Vapour Deposition). Here one has to differentiate between thick layer CVD, brazed as a self-supporting layer with a thickness of some tenths of a millimetre and machined to a cutting edge, and thin layer CVD, the true to profile diamond coating of a tungsten carbide cutting edge with a layer thickness of a few microns. CVD diamond comprises of many small diamond grains, which are intergrown (without a binder). Its use as a cutting material is in its infancy but diamond cutting edge coatings are promising as the wear resistance of diamond can be used on complex shaped cutting edges.
The rounding of the cutting edges of a few hundredth millimetres as a result of coating is a disadvantage for woodworking and these edges are rarely suitable for finishing.

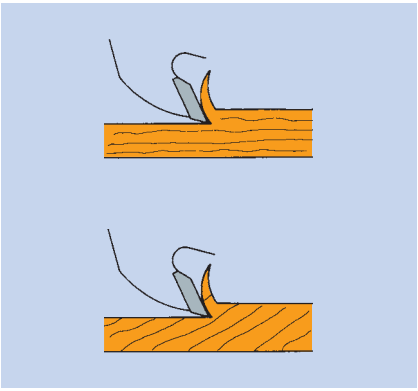
1.8 Important information and tables

1. Essential geometry elements in a cutting tool

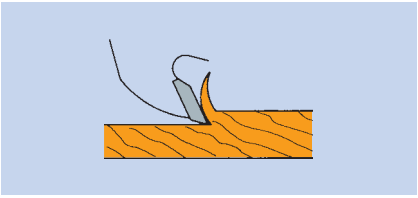


Diameter	d	
Cutting angle	γ	Gamma
Wedge angle	β	Beta
Clearance angle	α	Alpha
Shear angle	λ	Lambda
Setting angle of the edge	κ_r	Kappa
Cutting angle secondary cutting edge	γ_N	
Leading edge angle secondary cutting edge	β_N	
Clearance angle secondary cutting edge	α_N	
Cutting width	SB	

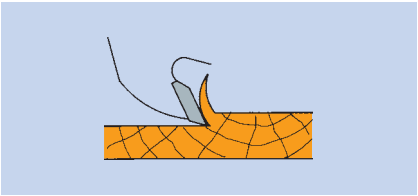
2. Cutting directions when machining wood



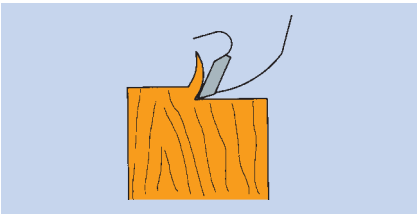
Cutting along grain with the fibres.



Cutting along grain against the fibres.



Cutting across grain.



Face cutting.

a) Cutting along the grain

1. With the fibres
Easy to cut – excellent surface quality at high feed speeds.

2. Against the fibres
Difficult to cut as the fibres tend to lift. If possible this cutting direction should be avoided by using alternatives for example changing the direction of rotation (against feed/with feed).

b) Cutting across the grain

Easy to cut but the surface finish is slightly rough.

c) Cutting the end grain (face side)

The fibres are cut vertically, high cutting forces and difficult to machine. Comparably rough surface finish from the torn fibres. Only low feed speeds possible.

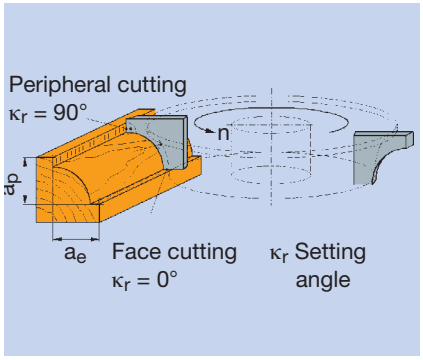
3. Cutting methods

a) Peripheral cutting

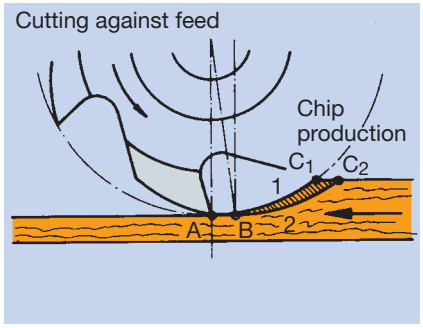
The circumference of the cutting tool machines the workpiece surface. The axis of rotation of the tool and the workpiece surface are vertical to each other. The enclosed angle, $\kappa_r = 90°$, is called the setting angle.
Examples: planing, jointing.

b) Face cutting

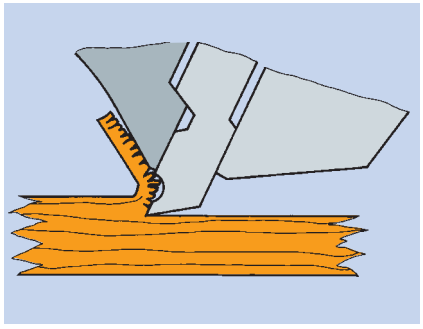
The face of the cutting tool machines the workpiece surface The axis of rotation of the tool and the workpiece surface are parallel to each other. The enclosed angle $\kappa_r = 0°$.
Example: panel raising profiles



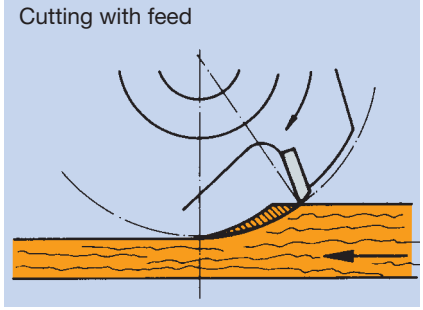
Cutting methods.



Chip production against feed.



Effect of a chip breaker.



Chip production with feed.

c) Profile cutting

Profiling is a combination of peripheral and face cutting, irrespective of whether the tools have shanks or bores. In general, with profile cutting there is a smooth transition from peripheral to face cutting. Any setting angle between ($0° \leq \kappa_r \leq 90°$) can occur.

– Simple examples: rebating, grooving or slotting.
– Other examples: machining of curved profiles, finger joint profiles or any decorative profiles.

4. Operating conditions

a) Against feed

Cutting against the feed is recommended for manual feed to prevent accidents.
The direction of cut of the tool is opposite to the direction of feed of the workpiece. Iinitially the cut has a cutting thickness of zero. Before a chip can be form and slide across the cutting surface, the cutting edge presses against the workpiece at the start of the cutting angle. The final workpiece surface is created during this initial phase. As the cutting action increases, the cut becomes more stable because of the increasing cut thickness.
The final stage of the cutting process is when the chip breaks away, known as splitting.
AB: friction zone
B, C_1, C_2: longitudinal cut.

Advantages:

Pre-splitting can be used to help reduce cutting forces, required motor power and to increase the tool life.

Disadvantages:

If the direction of the fibres runs from the surface into the workpiece, pre-splitting creates a rough surface with torn fibres.

There are ever changing fibre and feed directions on CNC machining centres Special cutting practices are necessary to avoid unfavourable fibre cutting angles. A chip-breaker ahead of the cutting edge helps form the chip earlier and reduce pre-splitting.

b) Cutting with feed

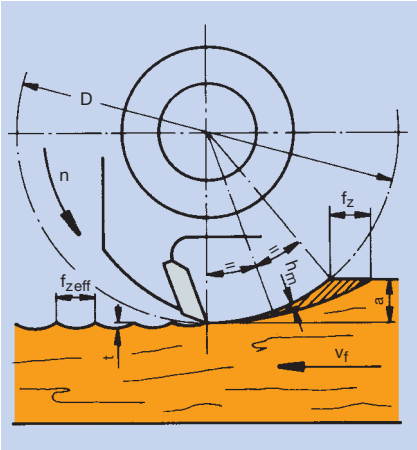
For mechanical feed only.
The direction of cut of the tool is the same as the direction of feed of the workpiece. Cutting starts at the maximum chip thickness, falling to zero by the time the cut is completed. With increasing cutting action, the chip becomes thinner and finer and there is less risk of pre-splitting.

Advantages:

Comparatively good surfaces are obtained when there is an unfavourable fibre direction, Lower feed forces required allowing an increase in feed speeds.

Disadvantages:

The cutters are subject to heavier loading and wear quicker because of the reduced pre-splitting.



Surface finish and clamping sizes for peripheral cutting.

5. Surface finish with peripheral cutting

The peripheral cutting process produces the workpiece surface finish. By superimposing the rotation of the tool on the linear feed movement of the workpiece, a succession of cutting actions produce a wave effect on the surface of the workpiece. The pitch, depth and uniformity of these cutter marks or planing marks determine the machined surface quality. The dimensions of the cutter marks are a combination of the cutting radius, effective number of teeth, spindle r.p.m. and feed speed.

Terms and formulas:
Please see page 11.14/11.15 for formulas

v_c	=	$\pi \cdot D \cdot n / (1000 \cdot 60)$	Cutting speed [m s^{-1}]
n	=	$v_c / (\pi \cdot D) \cdot (1000 \cdot 60)$	Speed [min^{-1}]
v_f	=	$f_z \cdot n \cdot z / 1000$	Feed speed [m min^{-1}]
f_z	=	$v_f / (n \cdot z) \cdot 1000$	Tooth speed [mm]
f	=	$f_z \cdot z = v_f / n \cdot 1000$	Feed per rotation [mm]
f_{zeff}	=	$f_z \cdot 1 = v_f / n \cdot 1000$	Effective tooth feed visible on the workpiece (cutter mark length – mm)
t	=	$f_z^2 / (4 \cdot D)$	Depth of knife marks (mm)
h_m	=	$f_z \sqrt{(a_e / D)}$	Average cutting thickness (mm)
a_e	=		Cuttting action, cutting depth (mm)

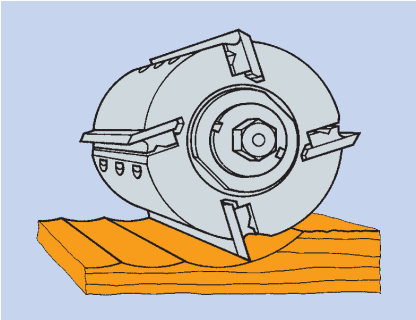
These formulas have numerical values. All the dimensions must have the dimensions noted in the brackets.

Top quality surfaces have cutter marks at regular pitches of between 1.3 and 1.7 mm. As the cutter mark length increases, the surface finish quality reduces and the tool life increases. As the cutter mark length decreases, the average cutting thickness also decreases. As a result, friction and wear increase and the tool life decreases.

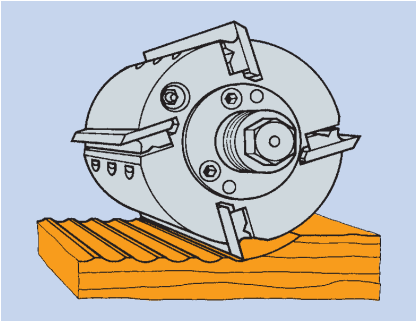
Single knife finish

Due to production tolerances, the cutting edges on a multi-knife tool do not have the same cutting radius. With conventional tool clamping (clearance fit between spindle and tool) normally only one cutter creates the workpiece surface. This is known as a single knife finish. The other cutting knives contribute to the cutting process, but do not set the finish surface quality on the workpiece. The cutter with the largest projection removes the evidence of the cutting action of the other cutters.

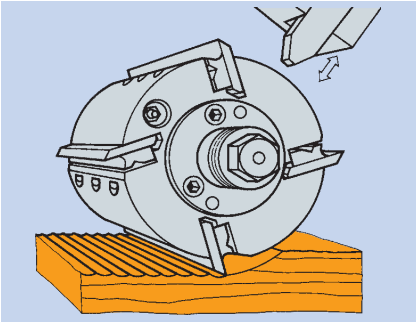
The visible cutter marks on the workpiece f_{zeff} corresponds to that of a single knife finish (z = 1). As the cutter mark pitch sets the quality of the workpiece surface, the feed speed is equivalent to z = 1 under these conditions.



Surface finish of conventionally clamped tools.



Surface finish of hydro-clamped tools.



Surface finish of hydro-clamped and jointed tools.

-> $f_{z\,eff} = v_f / (n \cdot 1) \cdot 1000 = f$
(f = feed per tooth/tooth progression)

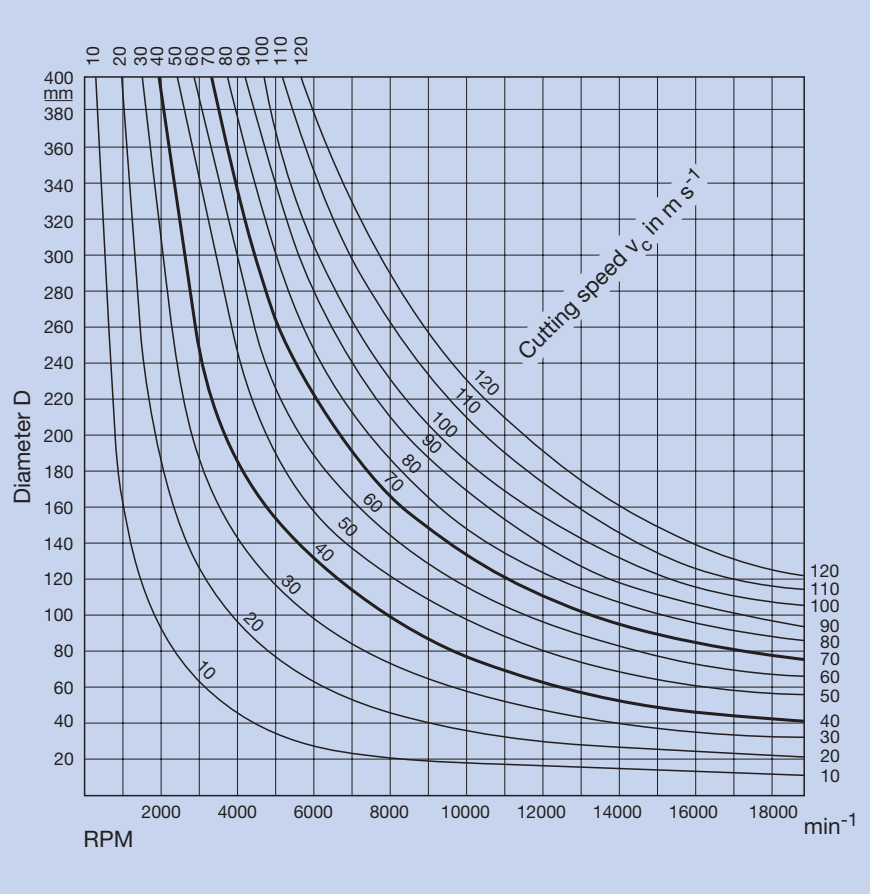
Multi-cut finish
The tool concentric run out tolerance is significantly reduced by a clamping system that centres the tool on the spindle, such as a hydro clamping system. With hydro clamping the cutting action of several cutters is now visible on the workpiece surface. The number and spacing if these is not regular because of the remaining concentric run out tolerance.

A run out tolerance of zero can be achieved by subsequently adjusting the radius of the cutting edges when the tool is clamped on the machine spindle by jointing. When jointed, the knife marks are at uniform intervals on the workpiece surface. This technology enables the feed speed to be multiplied by the number of cutters.
-> $f_{z\,eff} = v_f / (n \cdot z) \cdot 1000 = f_z$
(f_z = feed per tooth/tooth progression)

1.8 Important information and tables

Determination of cutting speed
in relation to RPM and tool diameter

The curves show the cutting speed in m s^{-1}, depending on the RPM and tool diameter. The required RPM can be determined if the tool diameter and cutting speed are known. Similarly, the tool diameter can be determined if the RPM and cutting speed are given. For BG-Test tools, the timber association specifies an optimum cutting speed range of v_c = 40-70 m s^{-1} because of the increased risk of kick-back and noise.



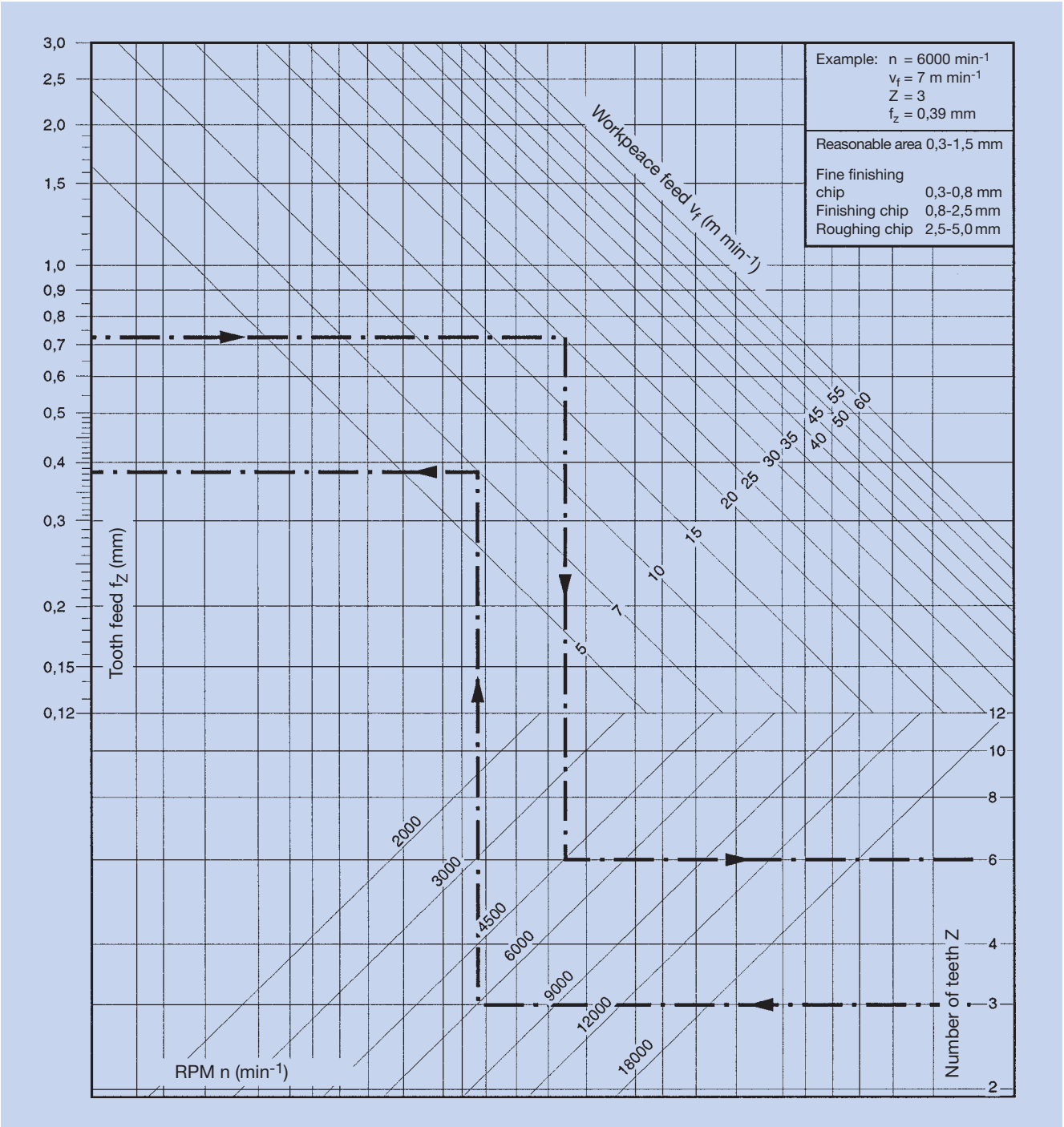
Guide values for cutting speed

Material	Cutter HS [m s^{-1}]	Cutter HW [m s^{-1}]	Sawblades HW [m s^{-1}]
Softwood	50-80	60-90	70-100
Hardwood	40-60	50-80	70-90
Chipboard	–	60-80	60-80
Coreboard	–	60-80	60-80
Hard fibreboard	–	40-60	60-80
Plastic-coated board	–	40-60	60-120

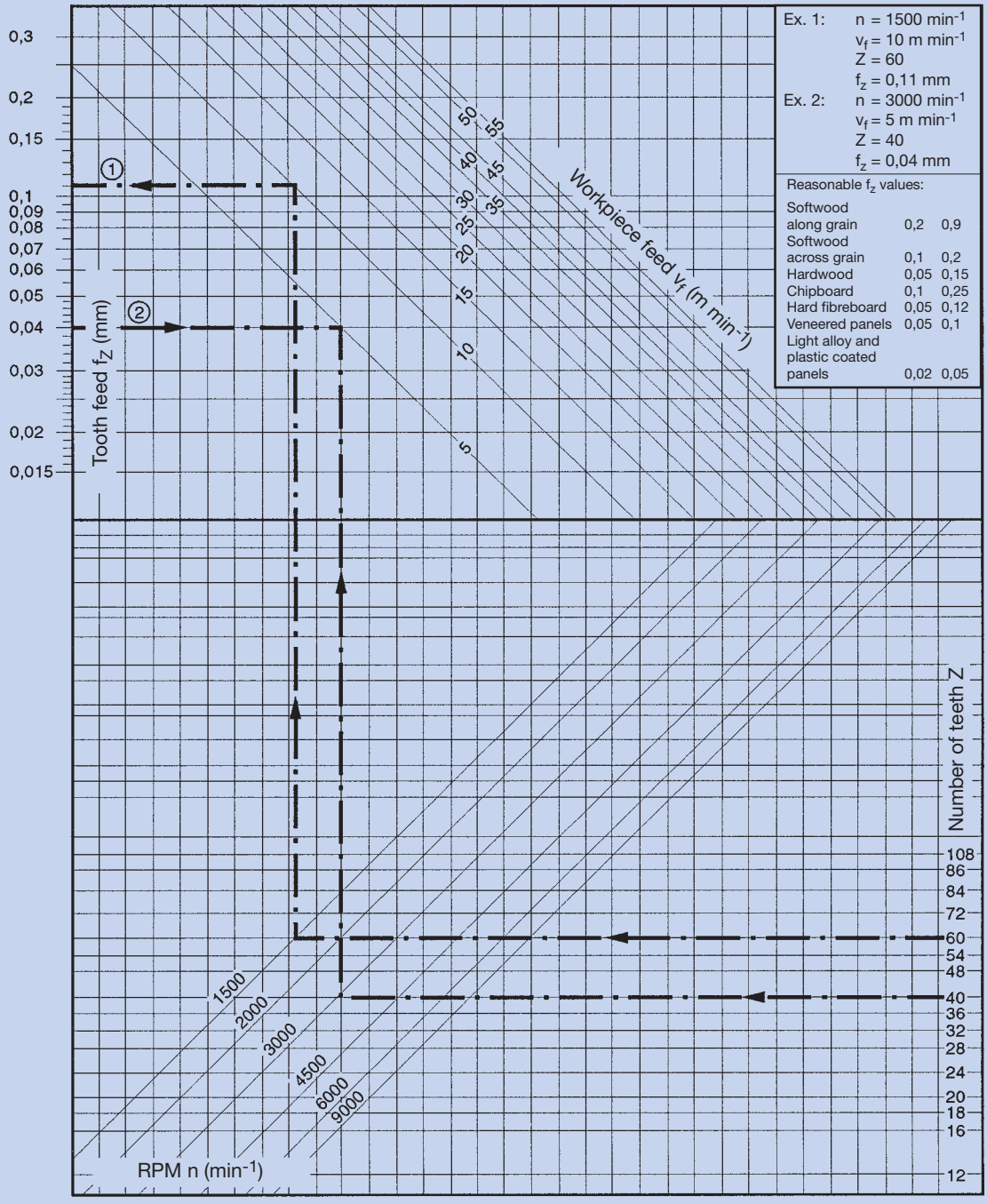
Example

Cutterhead: 120 mm Diameter, n = 12.000 min^{-1} -> v_c = 76 m s^{-1}
Cutter: 160 mm Diameter, v_c = 76 m s^{-1} -> n = 9.000 min^{-1}
Shank-jointing cutter: n = 18.000, v_c = 50 m s^{-1} -> D = 52 mm

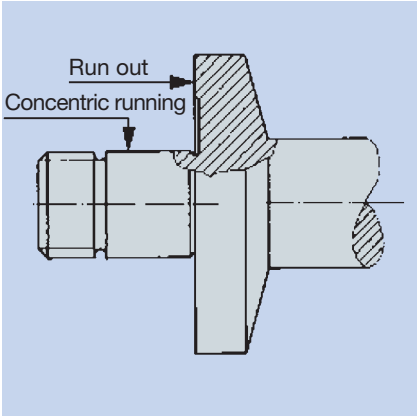
Parameters for cutting tools
Tooth feed, feed speed, RPM, number of teeth



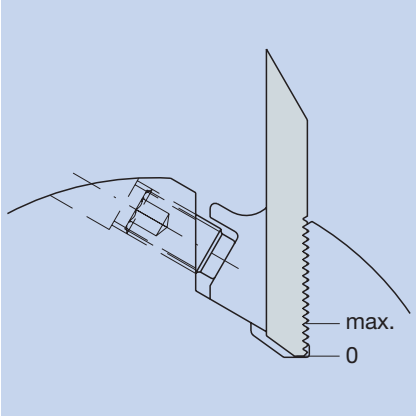
Parameters for sawblades
Tooth feed, feed speed, RPM, number of teeth



1.9 Actions prior to mounting a tool on the machine



Concentricity and run-out.



Please note the adjustable area.

1. Measures prior to fitting on the machine

As manufacturers protect tools from damage in transit, the user should also handle the tools with care. Damage can occur either through impact or when placing a tool on a hard surface. Cutters can also be cracked. It is important to protect all the tools (especially those with tungsten carbide or diamond cutting edges) from sudden impact and knocks.

The following steps should be followed before mounting tools on machines:

a) Thoroughly clean the tool and tool seating.
The tool bore and machine spindle should be cleaned before mounting to maintain the concentric running and run-out accuracy of the tool.

b) Repair or replace damaged tool seatings.

c) Only use surface ground spacers.

d) Check the concentric run out of the spindle with a dial gauge.

e) Check the tools for cracks or damaged cutting edges.
Check the tightness of the clamping screws on cutters and spurs of composite tools.
Note: only use the manufacturers recommended keys and spanners.

f) Check the workpiece clamping and feed.

g) Check the direction of rotation of the tool is correct.

h) Compare the maximum allowed tool speed with the machine speed.
On no account should the maximum speed be exceeded. The optimum machine speed is generally less than the maximum speed specified for the tool.

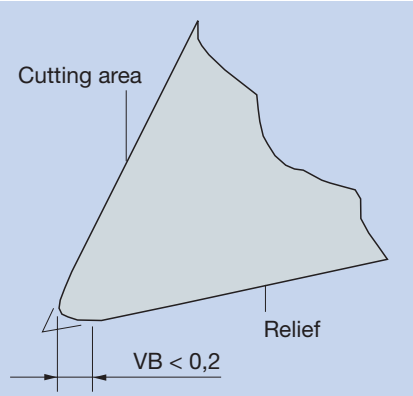
2. Action to be taken when using the tool

Tool wear and cutter condition should be checked during use to confirm the tool is servicable, and in particular to save costs. Do not under any circumstances wait until the cutter wear (blunting) has become too great or there are chips in the cutting edges. Measuring the power consumption with an ammeter is an easy way to monitor the condition of the tool.

Cutting generates dust particles which when mixed with resin or adhesive can form a build up on the cutters or in the tool gullet. Such build up reduces the cutting angle, reduces the size of the gullet and increase the power requirement. This build up reduces both the tool life and the surface finish quality and can, in extreme cases, even burn out the motors.

Cleaning tools is not a luxury but an essential part of their use. Tools should be cleaned of resin regularly, special commercial cleaning agents are available. For tools with aluminium tool bodies only use commercial cleaning agents with a pH value of between 4.5 and 8, otherwise corrosion can destroy the aluminium.
– But always follow the manufacturer's instructions.

1.9 Actions prior to mounting a tool on the machine



Maximum wear mark width.

Frequent removal of any resin build up applies particularly to tungsten carbide sawblades as even small cutter projections encourage a resin build-up. In some cases this can lead to cracks in the sawblades.

Air-borne material particles can damage the cutters if the dust and chips are not extracted efficiently. In addition to an increase in abrasive wear, chips can form on the cutting edges.

An extraction system, optimised in terms of extraction capacity and the pipe position, helps increase the life of the tools.

Regular maintenance is necessary for proper and safe use of the tools.

Tools must be resharpened when:
a) the workpiece surface quality is no longer satisfactory,
b) the wear mark width (VB) on the back relief is greater than 0.2 mm,
c) the machine power consumption is too high,
d) chips are found on the cutting edges.

3. Tool servicing

This means reinstating the cutter sharpness of blunt tools, as well as other repairs like, for example, replacing damaged cutting edges.

Servicing differs for the different materials, tipped high-alloy tool steel, stellite, tungsten carbide or diamond.

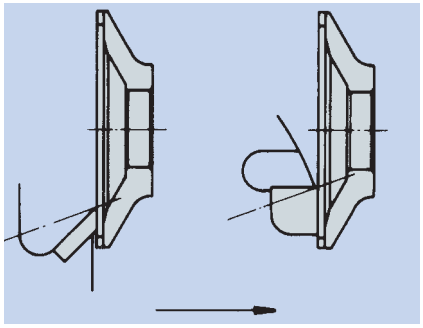
Special machining processes are necessary to minimise the temperature rise in the cutters during resharpening to ensure crack free cutting edges, that the cutting geometry is as drawing, to maintain the original dimensions and tolerances and that the cutting edge is sharp.

When servicing tools the following have to be observed:
– The construction of the tooling sets does not change.
– Tipped tools are be serviced by trained personnel.
– Only spare parts to the manufacturer's original spare parts specification are used.
– Tolerances, to ensure precise clamping, are kept.

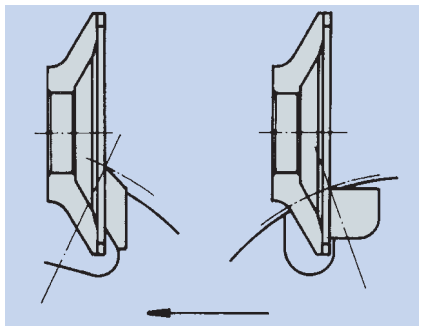
Leitz, with a world network of more than 180 service centres, has the professional knowledge plus state of the art machines to sharpen and repairing tools.

A list of addresses appears in the previous chapter under the heading "Leitz services and advice around the globe".

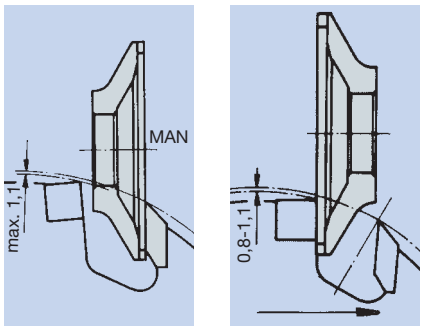
1.9 Actions prior to mounting a tool on the machine



Sharpening at the back relief.



Face sharpening. Tipped tools.



MAN-tools: cutting edge projection and limitor.

To avoid damaging the cutting material by overheating or stress cracks, it is necessary to use cooling lubricants when resharpening. Dry resharpening is not recommended. The specified tool body radius should not be changed when resharpening to avoid the risk of fatigue failure.

1. HL-, HS-, ST (satellite)- and HW (TC) tools (solid or tipped)

HW (TC) tools are sharpened with diamond grinding wheels. Carborundum or CBN grinding wheels are used for all the other cutting materials listed above.

Basic rules

- Thoroughly clean the tools before resharpening
- Maintain the concentricity tolerances – check with a dial gauge
- Spur projection over main cutter: 0,3-0,5 mm.
- The cutting edge projection should not exceed 1,1 m above the limitor on manual feed tools.

Tools with radial tipping

a) Grooving cutter with/without spurs

These tools are always resharpened on the top so not to change the cutting width.

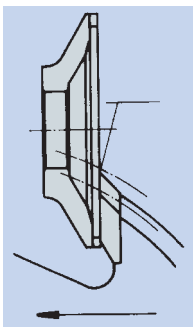
b) Jointing, rebating and bevelling cutter blocks

These tools are resharpened parallel to the face of the cutting edge or the spurs.

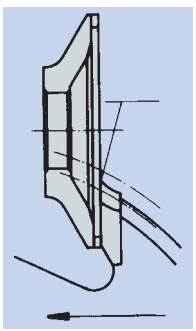
c) Profile cutter blocks

The shape of the tips depends on factors such as the cutting material, the profile depth etc. The back relief is set by one of three design parameters and depends on the purpose of the tool, either concave, straight, or convex. Resharpening is always done on the face of the cutter, not at the edge of the profile.

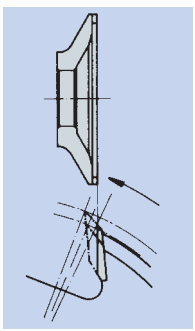
Profile cutterblocks with straight or concave back relief are resharpened parallel to the face, profile cutter blocks with convex back relief are resharpened by rotating the cutter axis. The maximum permissible cutting edge projection for manual feed profile cutterblocks (MAN) of 1.1 mm must not be exceeded.



Straight back relief.

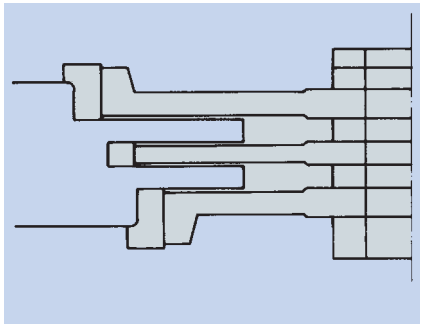


Concave back relief.



Convex back relief.

1.9 Actions prior to mounting a tool on the machine



Slot- and tenon cutters.

2. HS-slot an tenon tools

The special tips geometry ensures constant rebate depths when the same amount is ground from the face of every tip and removed parallel to the tip. For manual feed tools the maximum permissible cutting edge projection of 1.1 mm must not be exceeded. After several resharpenings the shimming must be adjusted to maintain the profile (adjusted with a spacer set).

3. Cutter blocks and cutter sets

The single tools are sharpened as guidelines 1 and 2 above. The amount removed during resharpening depends on the cutter with the most wear. All cutterbocks in a cutterset have to be sharpened to the same diameter, to maintain the original workpiece profile.

4. Diamond tipped tools (DP)

Diamond tipped tools can only be sharpened or eroded – on the top, using specially manufactured machines. Sharpening can be either by grinding or by spark-erosion. Special measuring equipment is needed to check the resharpened tools. Diamond tipped tools can only be serviced in those Leitz service centres with the specialist equipment or at the Leitz production plants.

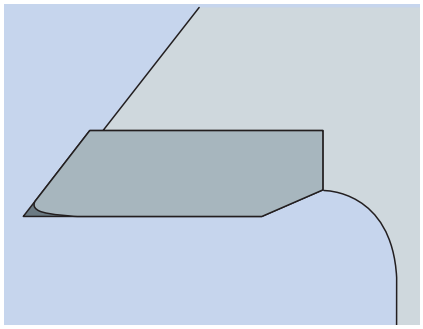
5. HW tipped circular sawblades

a) General information

HW-tipped circular sawblades should only be sharpened on special purpose automatic sharpening machiners. Manual sharpening on universal sharpening machines is not recommendable for quality and cost reasons. Automatic sharpening machines work on a plunge-cut grinding principle and are designed for wet grinding. Many of these machines are designed to resharpen all the standard and special tooth forms in a single cycle both on the face and on the top. Sawblades need to be thoroughly cleaned before sharpening.

b) Reduction of saw plate and body

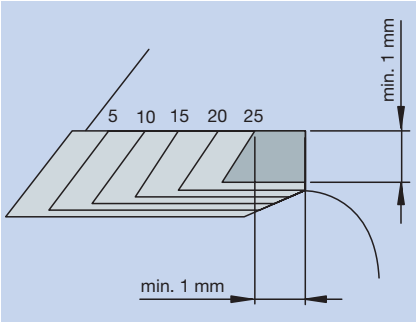
Only the tungsten carbide tips should be ground by the diamond wheel on the automatic resharpening machines, the saw plate must be reduced behind the teeth as a separate operation. To prevent stressing the teeth, the HW tips should not project more than 0.2 mm (with SB < 3.2 mm) or 0.5 mm (with SB > 3.2 mm) above the saw body.



Wear on a HW-saw tooth.

c) Resharpening

It is important to sharpen both the face and the top of HW circular sawblades. As a rule-of-thumb, the ratio for removal between the top and the face is 1:1 for the solid wood machining and 1:2 for the chipboard. Not removing the rounding at the tip edge totally results in a reduction in performance time. The sharpening machine instruction manual will advise on the necessary machine adjustments. Adjustment to the thickness of the sawblade is asymetric important as teeth cut in accuracy.



Leitz recommendation for height and thickness at the end of life of the sawblade.

d) Height and thickness at end of life
When the tooth height as measured from the tip seating is 1 mm, the sawblade is at the end of its life and should be scrapped for safety reasons.

e) Retipping
All Leitz service centres offer a retipping service for damaged HW sawblades. The new tip is applied by induction brazing using the correct materials and flux.

Knowledge of both the composition of tungsten carbide and saw body material is necessary – users are recommended not to carry out this work themselves.

f) Flattening and tensioning
Flattening a sawblade means eliminating any twists in the plate to achieve perfect flatness. Tensioning means stretching the saw plate at a point roughly half way between the periphery and the centre. Flattening and tensioning are usually carried out as one operation and are essential to the performance of the sawblade. Sawblades should be checked regularly during the resharpening process for flatness and tension and corrected if necessary. This is essential for multi-rip sawblades and thin kerf sawblades as they work under extreme conditions and can easily crack or fracture as a result.

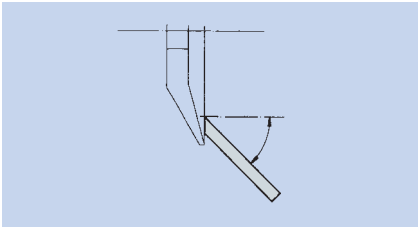
When in use a sawblade should be supported by the correct flange, the flange diameter is based on the diameter of the sawblade. This complies with DIN 8083. As a guide, the flange diameter should not be less than a quarter but preferably a third of the sawblade diameter.

6. Hogging sets

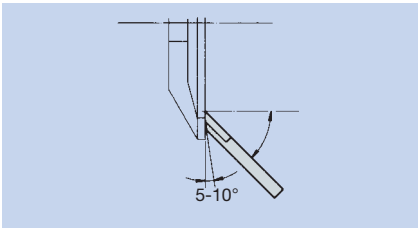
a) Hoggers
Hoggers consist of a sawblade and a hogging cutter screwed together. Hogging cutters must be ground on the top of the teeth and occasionally on the face, so that the relationship between the sawblade and hogging cutter is maintained. As the teeth are pitched equally it is possible and better to sharpen them on an automatic sharpening machine. This operation requires the hogging cutter to be mounted on a special sleeve.

b) Segmental hoggers
Segmental hoggers consist of hogging segments and a sawblade. The saw segment can be ground either whilst mounted in the hogging body on a conventional cutter sharpening machine or dismantled from the hogger body and mounted in a special fixture for sharpening on an automatic sharpening machine (as used for HW circular sawblades).

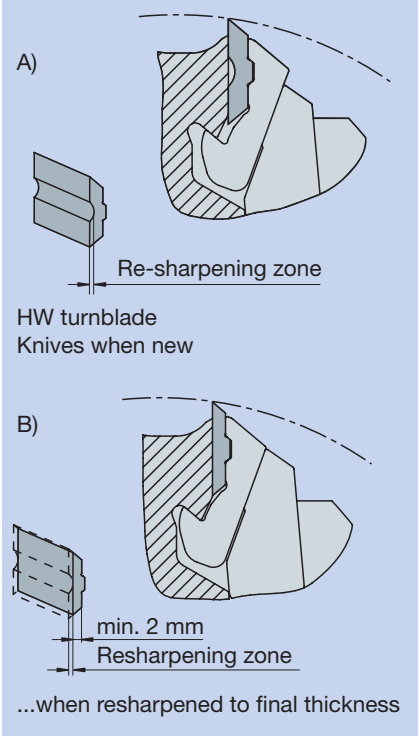
c) Diamond compact hoggers
A diamond compact hogger (DP) is eroded on all three edges (side, bevel and top) using a special machine.
If when used the tool is mounted on a hydro sleeve, sharpening must be carried out with the hydro clamping in operation to achieve the high concentricity and run-out accuracy.



Sharpening of planer knives.



Setting back of the knife basic material for HW-tipped planer knives.



Resharpening VariPlan knives.

7. Cutterheads

It is essential to follow the following steps when mounting planer knives:

1) All the tool body locating faces, knives and clamping elements must be clean and undamaged.
2) The clamping screws should be tightened from the middle to the outside (for larger cutting widths).
3) The knife setting should be checked with either a dial or a setting gauges (for planer knives).
4) Do not use an extension with the spanner or key when tightening the bolts or screws.
5) Spurs should sit perfectly in their seatings before the screws are tightened.
6) Cutterheads should be mounted on a spindle when tightening the bolts or screws to avoid distorting the body.
7) Seatings and wedges must not be modified in any way as they are specifically designed for maximum safety.
8) All knives and clamping elements should be of equal weight.
9) New knives and clamping elements should to be mounted in opposing seatings to match the weights and avoiding unbalance

a) Planer knives

HL, HS and HW planer knives are ground on the back only to maintain the original angle. To prevent the diamond wheel from touching the tool body when resharpening his knives the clearance from the steel backing must be maintained at 5-10° more than the actual carbide tip.

It is essential to remember the dimension tolerances when resharpening planer knives. The minimum clamping width should not be exceeded (see the marks on the side of the tool body). For a minimum clamping width of 15 mm and a radial knife projection of 1.5 mm, the minimum knife height is 18.5 mm for a a cutting angle of 27° and 19.2 mm for a cutting angle of 35°. Hydro cutterheads have a radial knife projection of 4 mm so, for the same minimum clamping width, the minimum knife height is 21.3 mm.

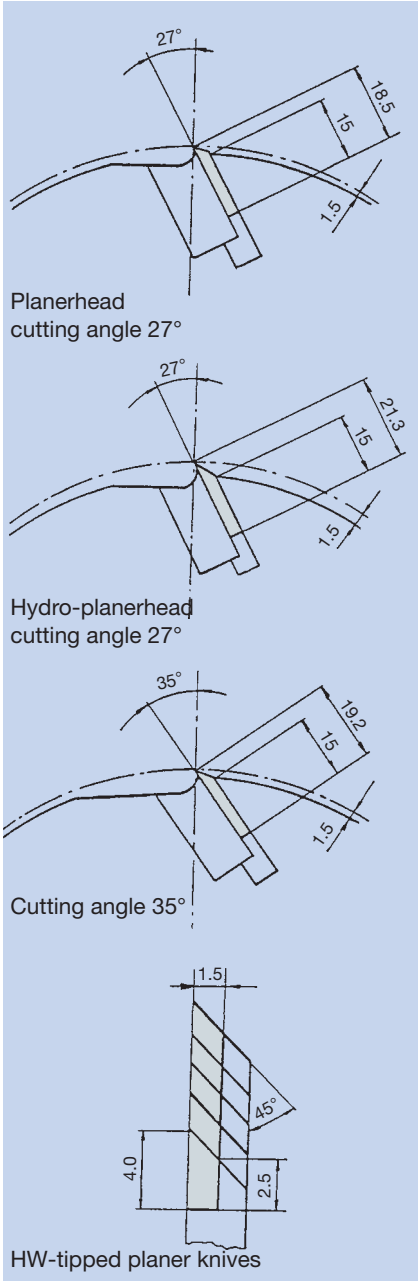
Attention must also be paid to the minimum tip height on HW tipped planer knives of at least 4 mm.

b) Variplan planerhead

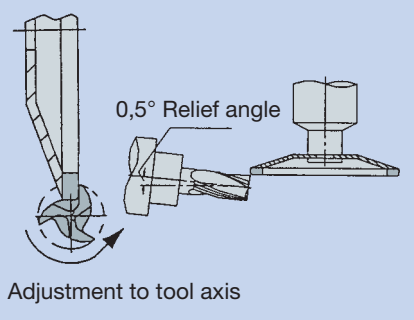
The cutter has resharpenable face sharpened turnblade knives.
The knives have a trapezoidal projection and are mounted in a special fixture for resharpening.

The resharpening depth of 1 mm is shown by a groove in the knife face. The clearance angle is adjusted by the clamping mechanism, so that after resharpening, the diameter of the tool remains constant and does not change.

1.9 Actions prior to mounting a tool on the machine



Permitted minimum heights of planer knives.



Resharpening spiral routers.

c) Spiral planerhead
Sharpening the 1 mm thick flexible HS knives requires a special fixture from Leitz. After sharpening, the knives are mounted in the clamping wedge which has the same shape as the knives in a setting stand. The user can then install the complete unit in the spiral planerhead.

d) Profiled knives
Profiled knives are ground on the edge of the profile, subject to the possible sharpening area and minimum knife clamping heights.

8. Router tools

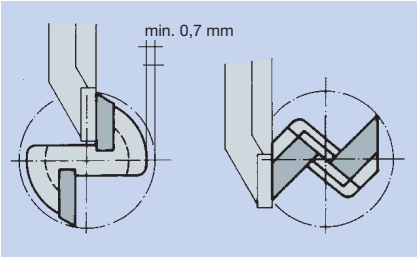
a) HS and HW spiral routers
These tools are manufactured in one of two designs either as a finishing cutter with max. 1-3 mm chip removal or as a roughing cutter for a high hogging performance.

Roughing cutters are resharpend only on the face because of their special profile. Finishing cutters can also be resharpened on the back relief.

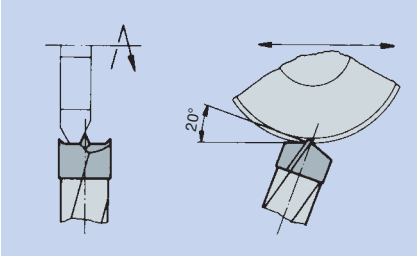
b) HS and HW routers with shear angle
These are face ground. If the cutting edge is chipped or burnt, the back can also be ground down to the next possible nominal diameter. The tips need to project at least 0.7 mm from the body cutting circle.

c) HW tipped dowel drills
Clamping the drill firmly in a collet before resharpening ensures a high concentric running accuracy. HW tipped dowel drills are resharpened on the cutter edge, centre point and spur in one operation with a profiled diamond wheel. The projection of the centre point and spurs above the tool body must be maintained. Profile diamond grinding wheels are available for all popular diameters.

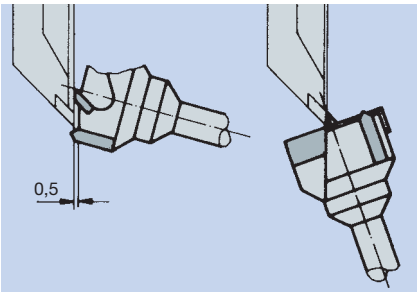
d) HW tipped hinge boring bits
Clamp the tool firmly in a collet before resharpening. The centre point and spurs are ground in one cycle. Before sharpening the edges of the main cutters, the tool body must be reduced so the body is below the main cutter by 0.5 mm. The spur should project above the main cutter by 0.3-0.5 mm and the centre point should project by 1.5-2.5 mm. If there is high wear to the main cutter it can also be sharpened on the face.



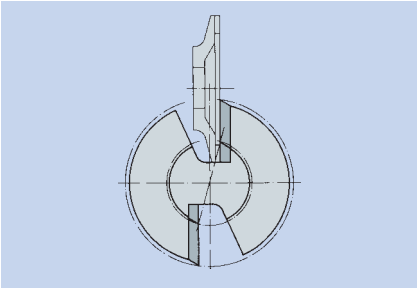
Resharpening routers with shear angle.



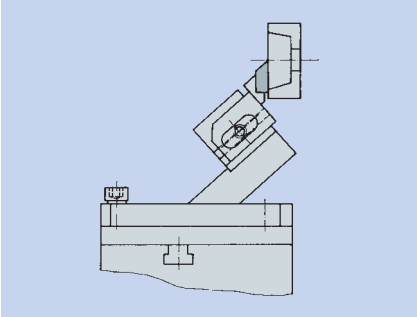
Resharpening dowel drills.



Resharpening boring bits.



Resharpening HW-tipped profile router cutters.



Resharpening DuFix knives.

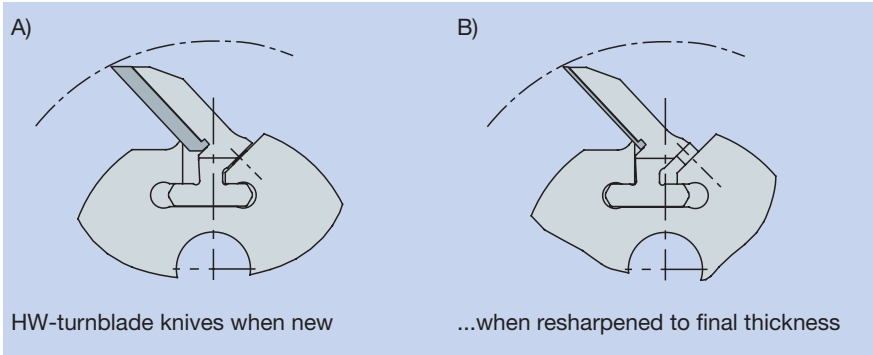
e) HW tipped profile router cutters

Profile router cutters are subject to the same sharpening guidelines as profile cutterblocks (1c). Profiled routers are clamped firmly in a collet before resharpening to maintain a high concentric running accuracy. The restricted gullet geometry of MAN-tools may require very thin grinding wheels with small diameters.

9. ProFix knives

HS and HW tipped ProFix knives are sharpened on the face once removed from the tool body and mounted in an adjustable fixture fitted to the table of the sharpening machine. This allows knives with different cutting angles (15°, 20°, 25°) to be aligned perpendicularly to the sharpening direction. HW tips can be ground down to a minimum thickness of 0.5 mm, achieving a high material utilisation.

– ProFix knives should only be sharpened in a Leitz service centre.



HW-turnblade knives when new ...when resharpened to final thickness

Resharpening of ProFix knives.

10. DuFix knives

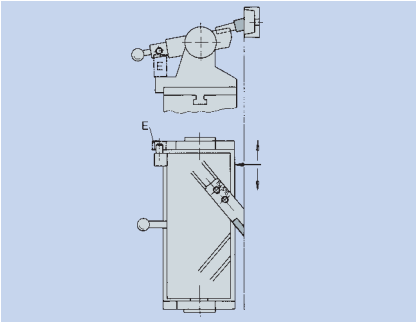
The HS and HW tipped DuFix knives are removed from the tool body and mounted in a special fixture fitted to the table of the sharpening machine. Adjust the DuFix knife so it is square to the face of the grinding wheel and tighten the clamping screws. Turn the clamping fixture to the correct angle for knives with shear cut, clamp the knives and face sharpen. DuFix grooving knives use an additional mounting fixture.

– DuFix knives should only be sharpened in a Leitz service centre.

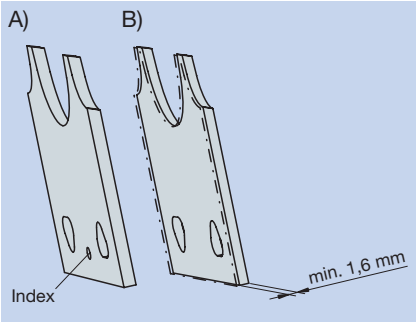
11. Exakt knives

The HS and HW tipped Exact knives are removed from the tool body, mounted in a special fixture fitted to the table of the sharpening machine and ground on the top. The knives are adjusted with a dial gauge to ensure they are parallel to the sliding action of the machine table.

1.9 Actions prior to mounting a tool on the machine



Resharpening Exakt knives.



Resharpening VariForm knives.

When clamping the knives in the fixture, the knife part number must always face up (visible to the operator). Using the instructing table, select the appropriate setting gauge and insert this into the fixture and tilt the carrier so it rests on the gauge. The knives are ground parallel on the top.

Exakt knives ground on the face need an additional part for the exact fixture or can be sharpened in the DuFix sharpening fixture.
– Exakt knives should only be sharpened in a Leitz service centre.

12. VariForm profile knives

VariForm cutterheads (HW) are ground with diamond wheels parallel on the front face of the knife, the cutting face.

Special sharpening machine fixtures are required, and these are installed at Leitz service centres.

The sharpening area is identified by a circular hole in the cutting face. Once this hole has disappeared, the knife is fully used and cannot be ground any thinner (minimum thickness of 1.6 mm!).

2.1 Sawing

Roof of the Hanover Trade Fair.

Wood, that basic raw material used in building, is one of our oldest resources. With the advent of the industrial revolution this natural growing material soon had many non-wood competing materials. None the less an industry sector has been established around wood – Wood Construction – that has mastered how to use the special advantages of wood. Today linked with sustainable forestry management we have an on going renewable resource for us all.

Whilst Leitz machine tools are designed to match the specific properties of the material, Leitz also sees “quality” and “time” as being as important when evaluating the cost-benefits of the tool. An unmatched range of sawing, planing and profiling tools have been developed for sawmills and medium sized companies in the wood construction industry.

The choice of Leitz tooling systems reflects the current trends in wood construction.

Sawing

Sawing starts the conversion process in sawmills and the first step uses gang saws, bandsaws, circular and chain saws. Leitz has sawblades for use on all types of machine, single-saw, multi-saw and profiling machines, and all applications, trimming, ripping, crosscut and mitre, used to saw wood in the wood construction industry.

The measurement tolerances below differentiate the cut qualities when machining solid timber.

Rough sawn.

Glueable.

Varnishing finish.

Sawn (coarse) = Measurement tolerance max. 0.5 mm

Glueable (fine) = Measurement tolerance 0.1-0.2 mm

Paintable (smooth) = Measurement tolerance max. 0.1 mm

It is very important to choose the correct tooth shape and number of teeth to optimise the workpiece surface quality and tolerance.

Single or multi-rip sawing machines are used to cut along the grain with either standard or thin kerf sawblades. Sawblades with wiper teeth are recommended on multi-rips when the cutting depth is over 40 mm or when cutting solid wood with high internal stresses.

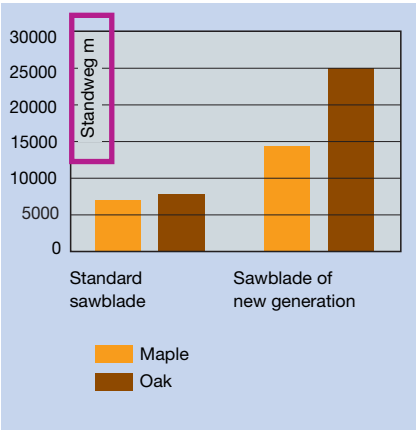
Sawblades with wiper teeth are used:
- up to 250 mm in diameter only with wiper teeth on the outside
- with high cutting depth in wet and dry wood with wiper teeth on the inside and the outside for improved chip flow
- for higher accuracy in dry wood only with wiper teeth on the outside.

Shoulder sawblades are recommended when cutting short pieces or when the cutting pressure is on one side the sawblade.

2.1 Sawing

Sawblade with outside and inside lying peripheral cutting edges.

Leitz-sawblade with extremely small cutting width and special coating.



Thin kerf sawblades are ideal when manufacturing a large quantity of thin workpieces such as slats, strips, louvres, bars or similar special products. Thin kerf saws maximise the use of raw materials by minimising the cutting waste. Thin-kerf technology can also be used in sawmills. Leitz has, by optimising all the process steps, reduced the sawblades kerf from 3.8 mm to 3.0 mm when cutting 95 mm thick spruce. In addition, tool damage has been reduced.

Extremely thin sawblades are beneficial when producing thin workpieces from exotic and expensive woods – either hard or softwoods.

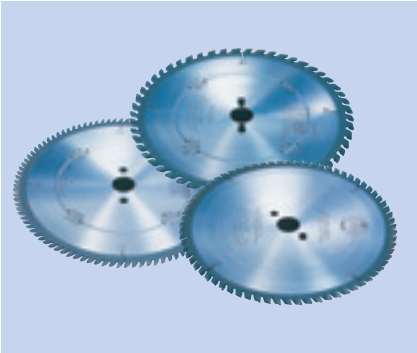
However, special criteria need to be observed when drying and preparing the wood:
- Humidity 7-8 % ±1
- Uniform drying
- Release drying tensions over an appropriate time span
- Harmonise the humidity to the humidity of the surroundings.

When using sawblades horizontally the riving knife has to be adjusted carefully. The riving knife thickness must be 0.3 mm thinner than the cutting width of the sawblades and the upper surface of riving knife must be level with the top of the saw teeth.
Leitz thin kerf sawblades have a special plate coating, which increases the cleaning intervals significantly. An odd number of teeth and irregular tooth pitch also improve the run time and surface quality. Depending on the application kerf widths from 1,2 to 2,5 mm are now possible.

Special care should be taken with sleeves and spacers, which can only be used when clean and undamaged. Instead of the traditional spacers used in the past, by adopting the Leitz closed hydro system Hydro-Duo sleeves with integrated aluminium locking ring, the sawblades can be positioned anywhere on the spindle. Centralised clamping reduces the unbalanced mass of the assembly and machine vibrations. This improves the cut quality and tool life. When thin kerf sawblades on Hydro-Duo-sleeves are used on vertical spindles, a centralising fixture simplifies mounting the tools on the spindle.

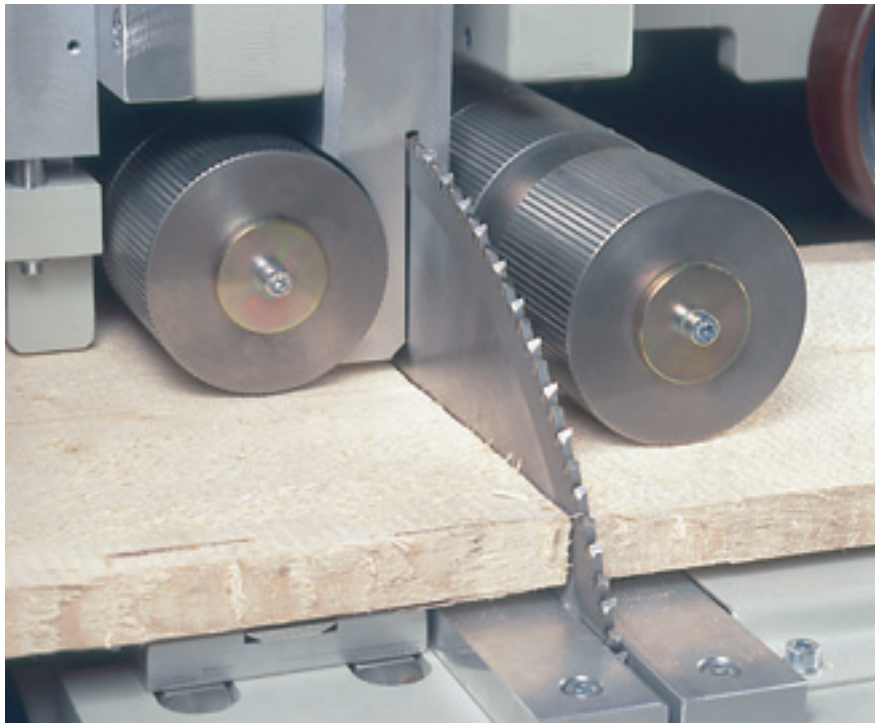
Sawblades on cross cuts have many applications in wood construction, from cross cutting by hand at a sizing station, to optimised sizing in industrial wood construction production with on-line optimising software.
Defect cutting of the timber for subsequent mini-finger jointing can be carried out precisely and automatically by cross cutting accurately at the right place to within a millimetre. Depending on the requirements and the type of workpiece the saws can cut from above or below the workpiece.

2.1 Sawing



Sawblades with a negative hook angle are invariably used on hand fed machines when the saw spindle is above the work piece. Sawblades used to cut wood across the grain can be noisy so Leitz has developed low noise sawblades that reduce the noise emission from the axial body vibrations. Specially designed tooth and gullet geometry, plus saw plate damping result in a considerable reduction in noise levels.

AS-OptiCUT-UT sawblades reduce noise levels significantly when free running from their irregular pitched teeth and saw plate design; **AS-OptiCUT-UT sawblade** reduce operating noise levels by up to 8 dB (A). Foil laminated **AS circular sawblades** are a further development of direct saw plate vibration damping giving noise reductions of up to 10 dB (A) plus the additional benefits of longer run times and improved cut quality.

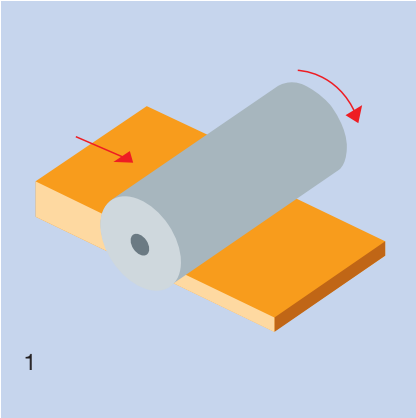


2.2 Planing

After ripping planing is the first production step and gives the reference surface for the subsequent processing steps.

There are 2 different methods:
1) traditional planing with planerheads
2) planing to the “Rotoles principle”.

Surface planing to the “Rotoles principle” is with a special planing cutter-head on the end grain across the wood grain. The resulting open wood fibres give a good gluing surface. This method is used more in recent years in solid wood panel production but there are still only on a few machine types available. The following pages concentrates on surface planing with conventional planerheads.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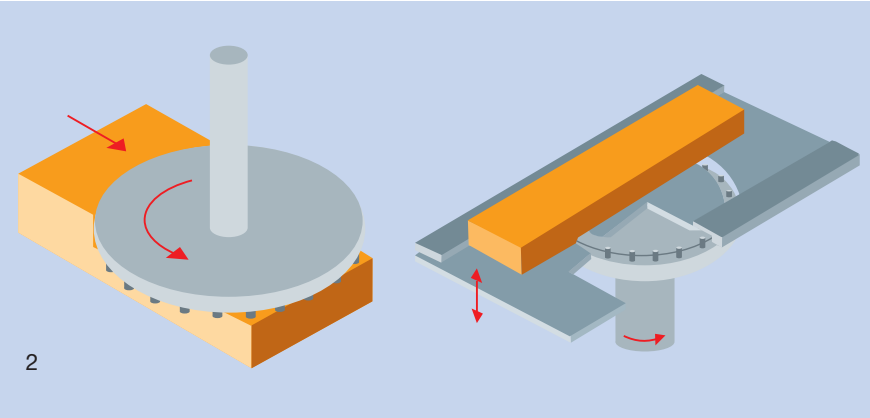
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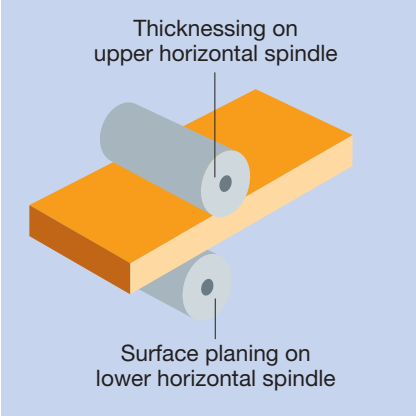
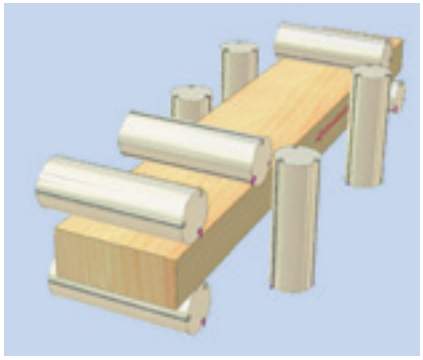


Surfacing
In planing we distinguish between surfacing and thicknessing.

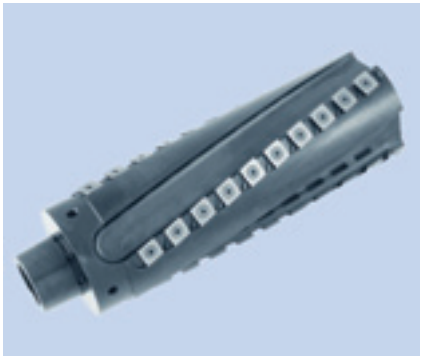
When surfacing the workpiece is straightened and levelled. Excessive pressure should not be put on the workpiece during this cutting process or it may deform. For a perfectly flat surface the workpiece must be fed by hand across the planerhead. This type of feed is classified as manual feed, even if the machine transports the material away mechanically.

Tools used for surfacing planing need the following features:
– reduced kick-back to be suitable for manual feed
– noise-reduced
– low cutting forces.

Spiral planing heads are available for manual surface planing machines. This design of tool gives a better surface finish quality and reduces the noise level. For further noise reduction the table lips can be split like a comb.

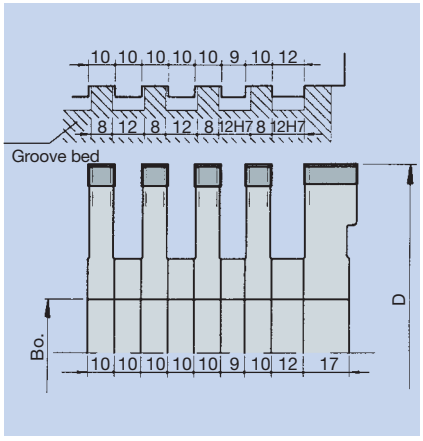


Spindle layout for 4-sided planing.



HeliPlan planerhead.

Surfacing with reference rebate.



Groove bed.

Four-side planing
Four-side planing machines are through-feed machines with multiple spindles (minimum 4) and plane all 4 sides of a workpiece in one process.

Surfacing/pre-planing
Because of the distortion of the workpiece when pre-cutting and at high feed speeds the chip load needs to be considered. Noise-reduced cutterheads reduce the cutting pressure and should be used because of location of the machine spindle relative to the operator.

The Leitz HeliPlan planing head has a segmental and spiral cutter arrangement meeting all these requirements and has additional benefits compared to conventional planerheads with long planing knives:
- Suitable for all types of solid wood (softwood, hardwood, exotic wood & glulam)
- Significantly reduced tear-outs on difficult timbers and around knots reducing the subsequent sanding and also the material size to allow for sanding.
- HeliPlan can also be used for finish planing, as the overlap of the individual knives is barely visible.
- Heliplan is the ideal tool for the planing glulam. If there is a chip in one cutting edge only this individual cutter has to be turned or replaced, not the complete knife as on a long planerhead.

Guiding the timber through the machine is critical in producing straight accurate workpieces. A rebate cutterhead attached to the first bottom spindle planerhead machines a rebate to guide the workpiece to first vertical fence spindle.

The first fence spindle machines the second reference surface and removes the rebate machined by the first bottom spindle.

Alternatively a groove bed can be used when machining short workpieces.

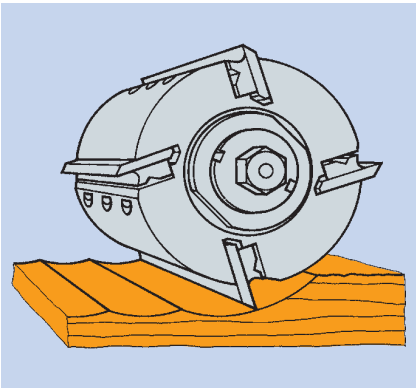
On a machine with a groove bed, grooving cutters are used on the first horizontal bottom spindle. The grooves in the workpiece are matched by grooves in the machine table. Groove bed profiles vary with the machine manufacturer and machining requirements and need specific tooling sets. The grooves are removed by a planerhead on the last bottom spindle.

Finish planing
Pre-planing is primarily to create straight workpieces or for reference surfaces. The primary requirement for finish planing is a good surface quality. Machine configurations of more than four spindles enable process optimisation by dividing the process between pre- and finish planing. This way the tools can be matched to the application benefiting both product quality and subsequent costs:

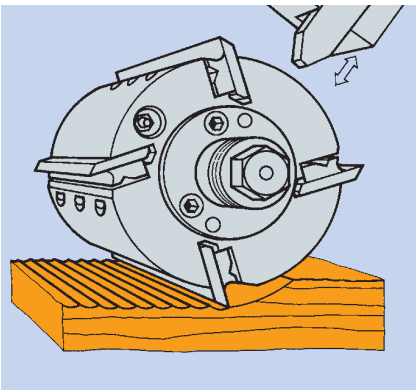
Centro-Star planerhead.

Workpiece surface
Finish planing without pre-planing.

Workpiece surface
With pre-planing and finish planing.



Planing with conventionally clamped tool.



Surface on hydro-clamped and jointed tool.

When pre-planing, it is important that any surface marks in the workpiece are less than that to be removed by the last cutterhead. Finishing tools are designed to give an excellent quality with a cutting depth of between 0,5-0,8 mm. Special requirements, like glueable surface finish or ready to varnish surface quality, can only be achieved with special tooling:
Leitz VariPlan or Leitz CentroStar planing heads can be used as both have integrated chip breakers.

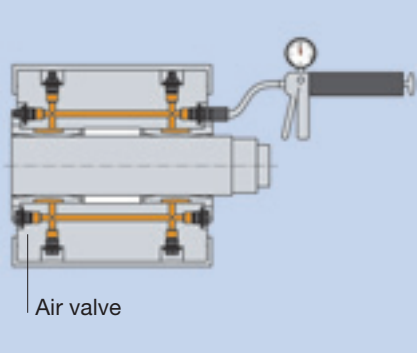
Hydro-planerheads with jointed knives are used for high speed – high surface finish planing. Even at high feed speeds cutter mark free finishes are possible.

Conventionally clamped tools:
Run-out arises from:
– tool run-out tolerance
– tolerance between the tool bore and machine spindle
– machine spindle run-out tolerance.

Run-out causes a one-knife finish and visible knife-marks on the workpiece.

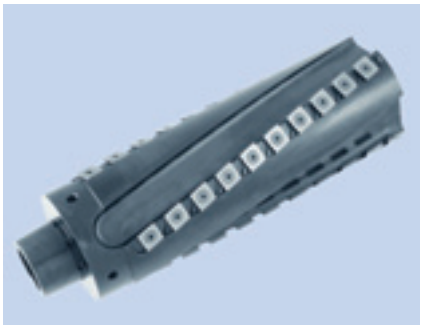
Hydro-clamped tools:
Run-out is reduced by:
– minimising the bore-to-spindle tolerance by hydro-clamping
– the remaining bore run-out is eliminated by jointing.

The marks of all the knives on jointed tools show on the workpiece as regular pitches:
Higher feed speeds are possible with the same number of wings compared to tools with conventional clamping.
There are many requirements for the machines and machine lines. Besides optimising the machined quality and production capacity the machines need to be flexible and easy to set up. For flexibility, easy set up and economics, there is a new alternative to the conventional systems of machine spindles and tool clamping technology.
Historically tools were mounted on straight spindles secured by spindle nuts or hydro clamped aided by mechanical locking collars. Today HSK cones are the interface between the machine and the tooling giving more flexibility and greater accuracy.

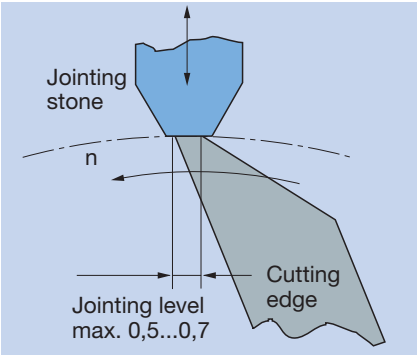


Hydro-clamping technique.

HSK-adaptor
(Leitz Powerlock).



HeliPlan planerhead with
Powerlock interface.



Jointing of planing knives.

The advantages are:
– reduced machine downtime arising from shorter set up times
– significantly improved run out tolerance and balance quality
– significant increase in product quality from a higher cutting speed.
– higher productivity and feed speeds without a loss of quality.

The Leitz Powerlock tooling range has economical and proven solutions for all applications.

Planing is a basic production step and the starting point for further processing steps. Accuracy is an important factor in the processing costs, as important as dimension repeatability and the machined surface quality.

A better machined finish means less sanding – increased quality and reduces costs are now a reality with the right tooling solutions matched to the machine and material.

High performance planing
Feed speeds between 80 m/min and 600 m/min are used on high performance planing and profiling lines making solid wood components (tongue & groove) and construction timbers. Achieving such high feed speed without loss of quality places high demands on the accuracy and quality of both the tooling and the machine.

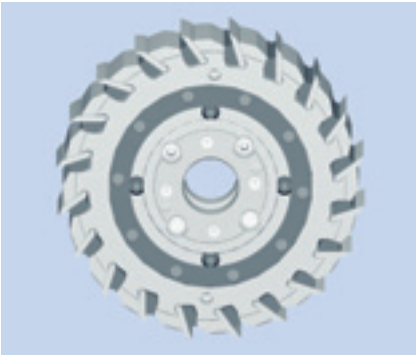
Jointing is a characteristic of hydro planing where all the planing knifes in the planing head are brought into the same cutting circle on the machine at the operating RPM with a jointing stone. Jointing eliminates any residual run out tolerances and every knife marks the workpiece surface evenly. The required surface quality, set by the length of the cuttermarks f_z, and the feed speed v_f, is calculated by the following formula

$v_f = f_z \times z \times n$

Z = number of knives, n = RPM of the spindle.

The possible number of knives, Z, depends on the pitch and diameter of the tool. Many knives require a small pitch and a large tool diameter.
The pitch is set by the space needed for the clamping mechanism and the minimum cross section of the tool body between the knife seatings. The maximum working RPM is limited by the centrifugal force on the knife seating and clamping mechanism. A higher feed speed means more knives and larger diameter tooling rather than increased RPM. The reason is the centrifugal force increases by the square of the RPM but only linearly with the tool diameter. High speed machines normally have tools with a diameter of 250 mm and a maximum feed speed of 200 m/min.

Side view of the RotaPlan hydro-planerhead.



Side view of the TurboPlan hydro-planerhead.

Conventional straight knife hydro planerheads – RotaPlan – have a diameter of 250 mm, a cutting angle 25°, a maximum z = 16 and a spindle speed of 5,300 RPM. A knife mark of $f_z = 1,5$ mm implies a feed speed of $v_f = 130$ m/min. Of a possible 200 m/min only 65 % of the feed speed can be used.
A higher feed speed is only possible with a lower quality. At 200 m/min the knife marks increase to 2,4 mm – not suitable for visible surfaces.

TurboPlan, a new generation of tools, is the best solution. This new compact design with integral hydro knife clamping benefits from a higher number of teeth for the same diameter of tool plus a higher RPM. For the above example this means that, for the same product quality, an increase in feed speed, and so production, of over 50 %, see table below. The maximum possible feed speed of 200 m/min can be achieved with no loss in quality.

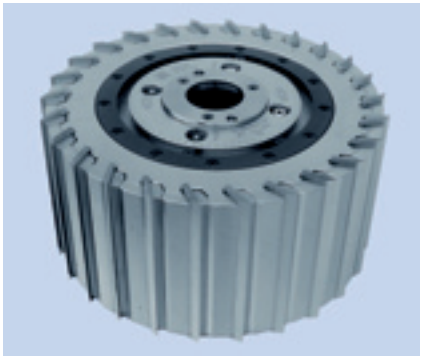
The TurboPlan system is also suitable for high-speed planing lines with feed speeds of 350-600 m/min. For a tool diameter of 300 mm, z = 26 mm, n(max) = 6,000 RPM and a feed speed v(f) = 350 m/min, the f(z) = 2,25 mm.

Performance data for different hydro-planerhead systems.

Conditions: D = 250 mm / f_z = 1,5 mm		**“RotaPlan”**	**“TurboPlan”**
Maximum no. of teeth		16	**20**
RPM	n_{max}	5.300 min^{-1}	**6.700 min^{-1}**
Feed speed	v_f	130 m/min	**200 m/min**
Performance increase		–	**+ 54 %**

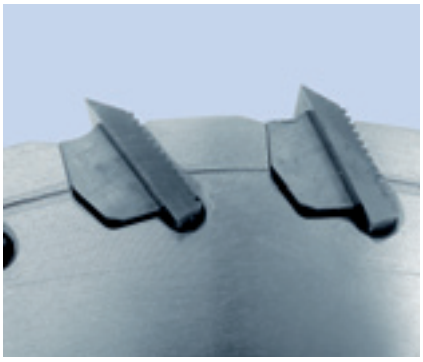
The large performance increase with the TurboPlan design is the result of a program of continuous product development. TurboPlan planerheads have the following characteristics:

– Simultaneous hydro clamping of all knives.
–> Smaller area for knife clamping by eliminating the clamping screws.
–> No weakening to the tool body by the clamping bolts.
–> Increase in the number of teeth without reducing the cutting angle.



TurboPlan.

TurboPlan –
adjustable balancing segments.



TurboPlan –
form-fit knife clamping.

–>No body distortion when tightening the knife clamping screws.
–>Significantly reduced knife re-setting time.

– Form-fit knives for location and clamping.
–>Higher feed speeds and RPM.

– Independent knife and cutterhead clamping.
–>Knife clamping mechanism unaffected when transporting the cutterhead between the toolroom and machine.

– Balanced with balancing weights.
–>No weakening of the tool body from balancing holes.

Increasing the feed speed and production without improving the tool run time means the increasing the number of tool changes so cancelling the speed advantage. The end of tool run time is reached sooner at the higher speed. The benefit of the increase in performance is cancelled by the increased number of tool changes, increases in the tool servicing and machine down-time.

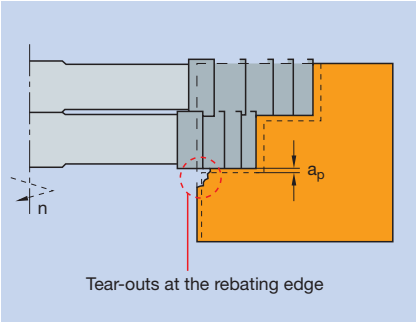
Only Leitz HS-marathon coated knives with their extremely hard surfaces are used in TurboPlan. The performance increase is 3-5 times that of standard HS knives. Again, referring to the above example, not only an increase in production by 50 % but a doubling of performance. The simultaneous knife clamping and the form-fit positioning means the resetting and sharpening time is reduced by a further 30 %.

Pre- and finish profiling
Dividing the machining process into a number of steps is a way to achieve a good product quality and reducing the quantity of second grade quality.

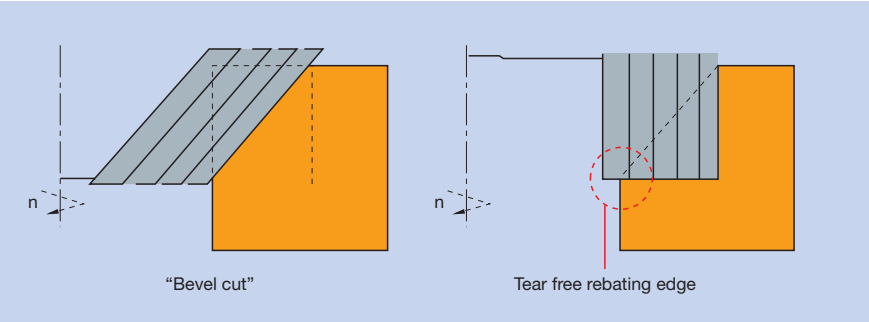
Profile matched pre- and finish cutting can significantly influence the result. Machining defects arising from the pre-cutting operation can still be visible on the final product and misdirect the search of the cause of the defect. Pre-cutting has to be to same quality level expectations as that for the final product. Pre-splitting causes tear-outs and chips reducing the product and finish quality and increase the volume of rejects and repairs.

Close contour pre-cutting must be considered from the aspect of the machined quality. In many cases close contour pre-cutting can reduce rather than increase the finished product quality.

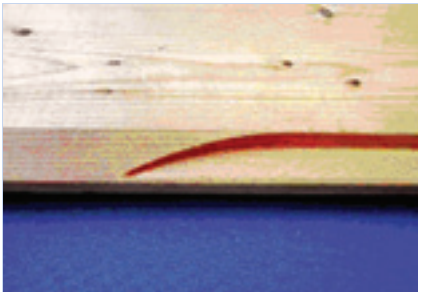
Recent work at Leitz has shown that bevel cutting rather than close contour pre-cutting can reduce pre-splitting – and the subsequent reduced product quality – significantly. Another advantage with this concept is that the pre-cutter is not for one profile, but can be used as a universal pre-cutter. Solid wood panels e.g. tongue & groove panels can be pre-cut with V-shaped pre-cutters. Splitting the final profiles between pre- and finish cutting can allow different profiles to be made without tool changes.
Tool life is extended as well as the other benefits.



Damage to the finished edge from contour pre-cutting.



Schematic illustration of bevelled pre-cutting.



V-shape pre-cutting of solid wood panels.

HL solid tongue cutter mounted on adjustable hydro-sleeve.

Groove cutter-set wing-on-gullet.

The finished profiles are machined with tool sets mounted on hydro sleeve adjusted and sharpened to a close run-out tolerance. The tool sets should not be removed from the hydro-sleeve after sharpening for adjustment because of the high quality requirement. If a two-part tool sets e.g. tongue & groove needs adjustment it must be done before being sharpened. The tools need to be designed so they can be re-sharpened when mounted as a set.

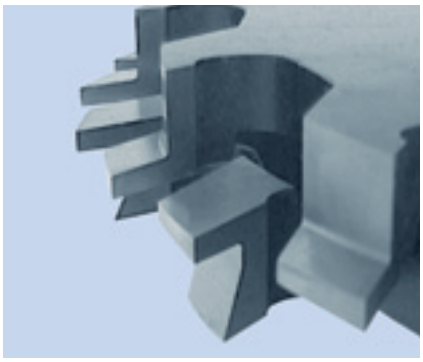
On conventional hydro-sleeves tool adjustment is with spacers but there is the risk of dust particles being trapped between the spacers reducing the accuracy. Leitz has developed a new hydro-sleeve that allows the tool to be adjusted without removal from the hydro-sleeve or machine spindle to prevent this occurring. The tool is adjusted by a high-accurate scale.

Adjustable tongue & groove cutter sets are mounted on hydro-sleeves. Sharpening these tooling sets in one machine cycle requires the face of the two parts of the tool to be in line.

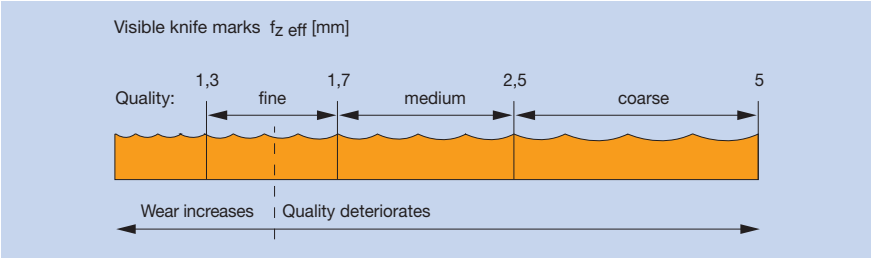
Every wing of the tongue cutter is part of the cutting process with this design but the groove cutter is different. As the groove wings have to overlap to adjust the width of the groove only half the teeth take part in the cutting process. The disadvantage of this construction is that only half the wings machine the groove on a groove cutter with a wing-on-wing design e.g. on a z 8/8 grooving cutter only 4/4 teeth cut the groove. The result is a reduced number of wings creating more tear-outs to the edge of the groove.

A significant improvement can be achieved by using groove cutter sets with a wing-on-gullet design. In a wing-on-gullet design the cutter parts are mounted so that the grooving tooth of one part lies in the gullet of the second so all the wings of the two parts of the tool are used in the cutting process giving a higher finish product quality. A disadvantage with this design is that, for same tool diameter, as the same number of teeth has to be located there is a reduced resharpening section and a longer resharpening process. Resharpening has to be done in two cycles. To minimise this disadvantage it is possible to design the tools so that during resharpening the tool parts can be positioned tooth-on-tooth. After sharpening the parts are repositioned tooth-on-gullet.

The advantages of this design outweigh the disadvantages, but the resharpening options need to be discussed when placing the order. Horizontal finish planing is carried out on the last two machine spindles – the recommended chip removal is 0.5-0,7 mm.



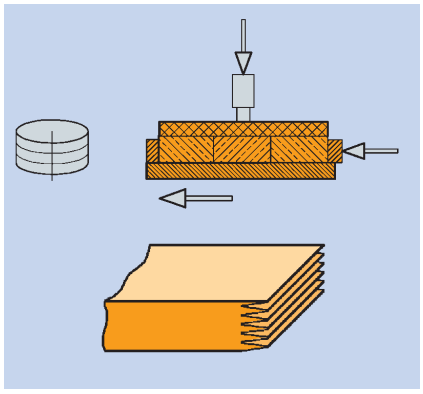
Groove teeth wing-on-gullet.



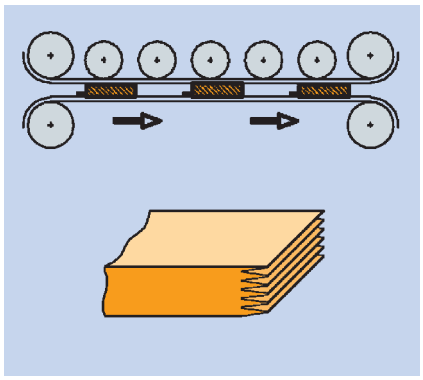
Relationship between surface finish and knife marks $f_{z\ eff.}$

2.3 Constructional finger jointing

Wood has a wide range of uses in construction for mouldings and non-structural components. Given the stability and aesthetic qualities of finger jointed timber, finger jointing opens up new areas of design for wood. Laminated beams would be impossible without finger jointing; internal fittings can be made as single pieces. By combining finger jointing and lamination, companies can now use the short lengths, previously burnt as waste, as a material that is both strong and has a long life. As well as the improved appearance of defect free timber, the technical characteristics – stability against warping and twisting – are much better than “one-piece” solid wood. Eliminating splitting, stability and visual appearance are important factors when using wood in construction.



Horizontal jointing on the sliding table machine.



Horizontal jointing on the continuous machine.

Wood in building is divided into two categories – load and non-load bearing parts. The profiles are usually set by regional standards. There are established profiles in the EU but outside Europe there are other finger profiles with different finger lengths, pitches and measurements (e.g. inch). But because of the long experience with finger jointed timber in Europe, European finger profiles are often used in many other countries.

There are different types of finger jointing machine having different production sequences, but they can be divided into those using short pieces of timber and those using long pieces of timber.

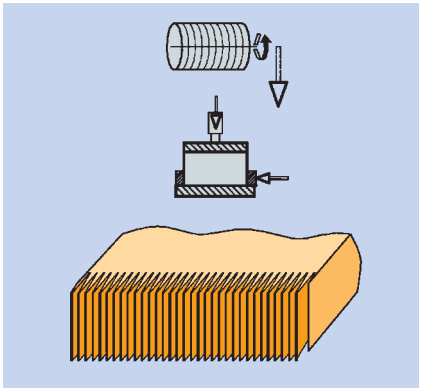
Short timber systems:
Machines for short timber lengths can have either a sliding table or continuous feed. The workpieces are placed horizontally on the machine table and profiled across the end of the timber. These procedures are not that important for wood construction.

Long timber systems:
These systems come in many variants. Several workpieces are – depending on the table width – clamped vertically and end profiled on sliding table machines. This is called vertical jointing and these machines are predominantly used for laminated beams. The process is different for horizontal jointing as the machine spindle is horizontal and the workpiece is profiled across its width. For greater efficiency the systems described above are made as double-sided machines.

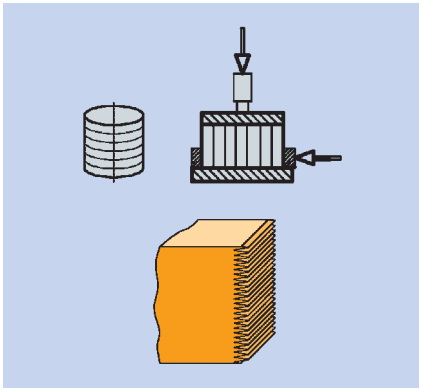
Another difference in the systems is the cut-off saw. Machines with a cut-off saw shorten the fingers to the desired finger length; the tools for these machines are made with longer finger profiles. As the tools blunt, the gap at the finger tip increases but this can be reduced with the cut-off saw without the need to resharpen the tools. This procedure is possible for a certain degree of bluntness and extends the tool run time. On machines without a cut-off saw the finger jointing tools profile the fingers to a precise finger length. The tools can, as they blunt, only be used to an acceptable tip gap size and so have to be resharpened earlier than those on a machine with a cut-off saw.

Strong joints need a constant and precise finger profile as the profile quality determines the strength of the finger joint.

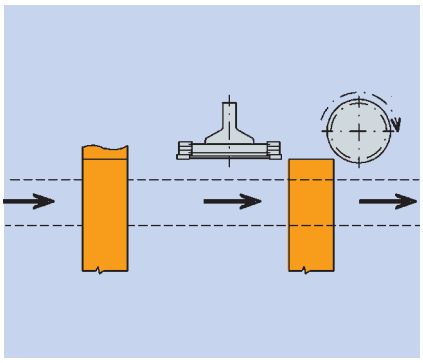
When machining the finger joint profile, the size of the tip of the finger can widen over the length of the finger by the action of the tool as the alternate cutters on the tool exit the workpiece.



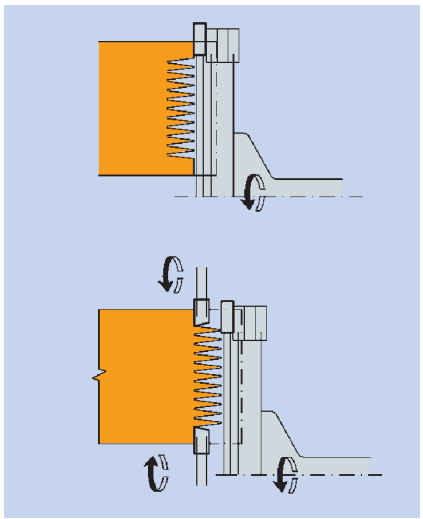
Horizontal jointing – compact machine.



Vertical jointing – sliding table machine.



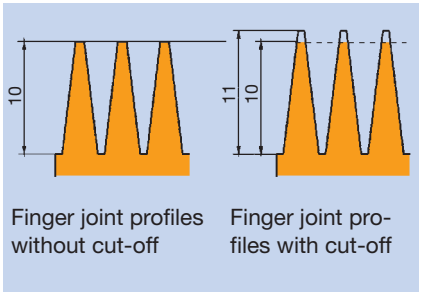
Continuous machine with cut-off hogger.



Jointing with closed shoulder joint.

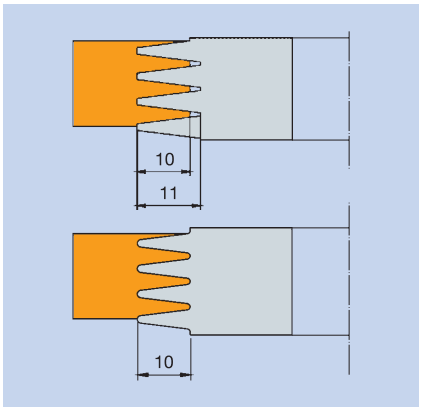
The reason is that as the cutter exits the timber the finger, which was profiled on one side by the previous cutter, is no longer supported and stable so deflects under the cutting pressure. This problem – which increases with increasing tool bluntness creates a bowed workpiece after gluing because of the uneven wood profile – cannot be completely eliminated, but sharp tools reduce it to a minimum.

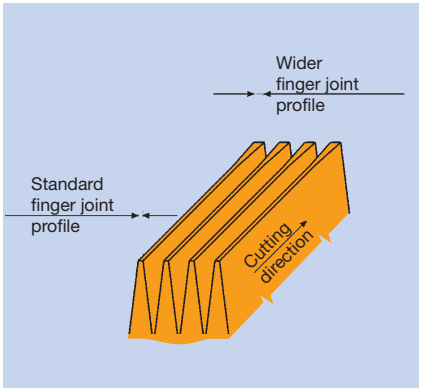
The economics are determined by the choice of cutting material. As well as standard high speed steel (HS), Leitz offers a special high speed steel. The finger joint cutter (WF 620-2-05) with a special HS tipping material has a performance increase of up to 4 times over standard tools. Finger joint cutters with this cutting material can be used instead of carbide tipped tools. But for abrasive exotic timbers containing silicates, only tungsten (HW) is the recommended cutting material. Leitz-Marathon coated finger joint cutters have a performance increase of a factor of 5 compared to standard HS. The Marathon coating also reduces the resin build up, prevents the tips jamming



Finger joint profiles without cut-off

Finger joint profiles with cut-off



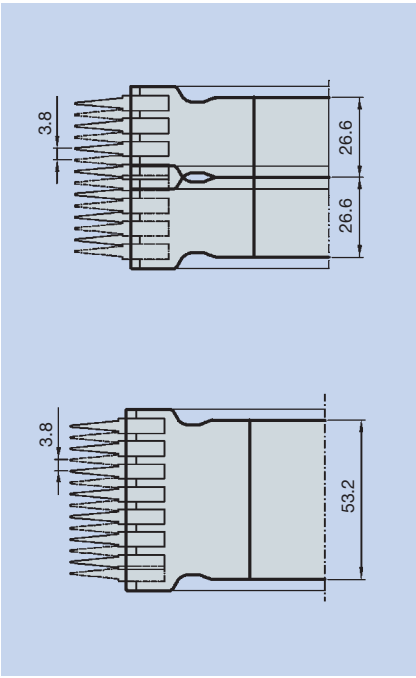


Profile problems because of the widening of the finger tip when the tool exits the workpiece.

Mini finger joint.

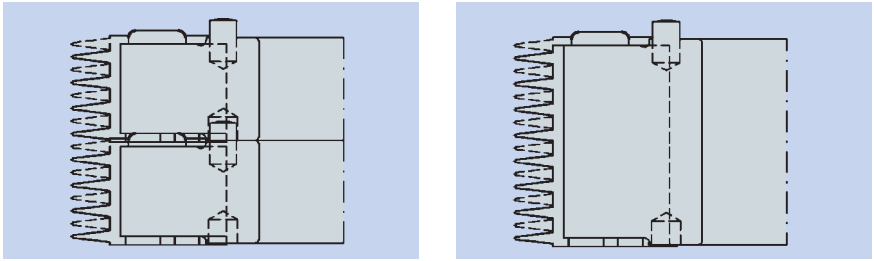
in the timber, reduces the cutting pressure and minimises tear-outs.

Leitz has a wide range of different types of finger jointing systems; all have their specific uses with different economic benefits.

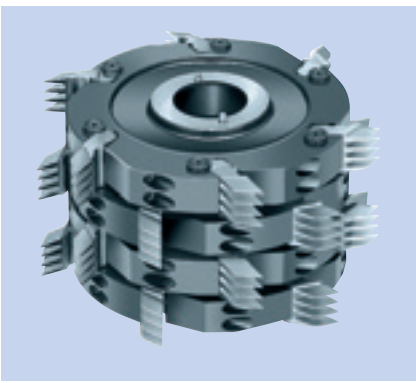


Mini finger joint cutter – modular cutting width system.

Mini finger joint
Tipped cutters are rigid and have HS, HS special or HW tips depending on the type of wood. The individually mounted tips reduce the risk of finger breakage to a minimum. They can be used on all machines with feed speeds up to 24 m/min. Finger joint cutters with double cutting width reduce the purchasing costs and lower the maintenance costs by halving the required number of tools. Narrow and wide tools can be combined to give the required timber width. Reducing the number of tool bodies increases the finger pitch accuracy by reducing in tolerances. Leitz Marathon coated tipped finger joint cutters are available to special order.



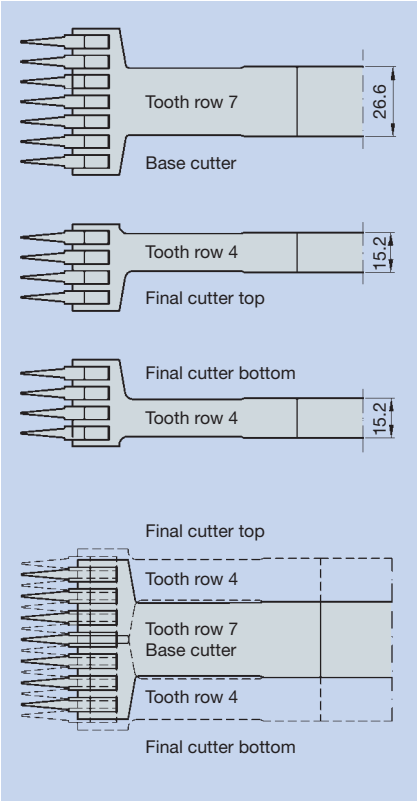
Mini finger joint cutterheads – modular cutting width system.



Mini finger cutterhead with Leitz Marathon coating WM 620-2-05.

Mini finger cutterhead with Leitz Marathon coating
Leitz finger joint cutterheads have Marathon coated HS knives with up to 4 times the performance of uncoated HS cutters. The higher cost of this cutterhead system pays for itself in a short time as only replacement finger joint knives are required and, if damaged, an individual knife can be replaced. These finger joint cutterheads are also available in double cutting width to reduce the purchase and running costs. Leitz finger joint cutterheads can be used for feed speeds of up to 24 m/min for all types of wood construction on machines with or without cut-off saw. Resharpening is the same as for standard HS-cutters. The coating makes cleaning easier as it is required frequently.

2.3 Constructional finger jointing



High-performance mini finger joint cutterset for continuous jointing.

High Performance mini finger joint cutters for high-performance machine systems

Today's new large heavy-duty machines have feed speeds of up to 50 m/min. The required finger quality and the bluntness of the finger joint tools contribute to the performance of the machine, but the productivity of the gluing station sets the feed speed. These machines require finger joint tools with more cutting wings. Leitz finger joint tools with 6 wings are the solution where economic efficiency and improved joint quality is required. The tips on these tools are in rows and the intervening gap closed by the tips of the next wing.

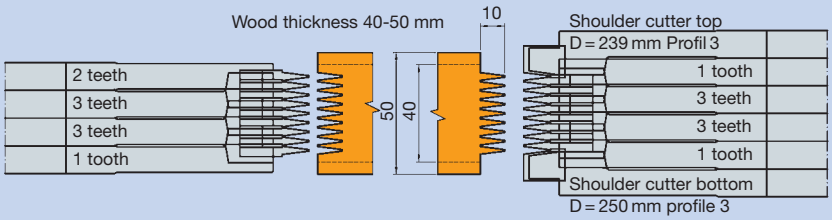
The advantages of this finger joint cutter Z6 compared to a tipped cutter are:
- More stable and rigid tool body.
- Improved joint quality as the fingers are supported by the cutting tips
- Fewer tool bodies so greater profile accuracy over large cutting widths
- Resharpening area of 12 mm compared to the 3.5 mm on a HW tipped cutter.
- Easier to resharpen accurately.

There are two mini finger cutter designs:
- Z = 6 for continuous jointing.
- Z = 6 for finger joints with shoulders.

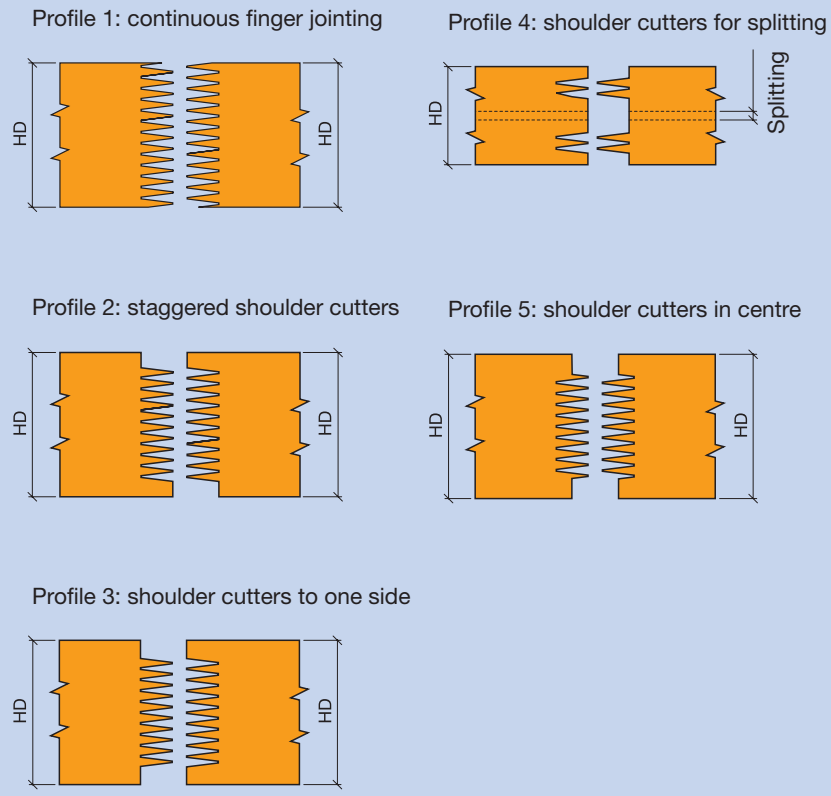
Z = 6 Mini finger joints

The full potential of any single or double sided finger jointing machine with feed speeds of 24-48 m/min and cut-off saws can be realised with Leitz Z6 tools. These tools can have either finger lengths of either 10/11 mm or 15/16.5 mm.

The quality is improved, productivity increased and scrap rate reduced. This high performance finger joint tool uses the special HS material.



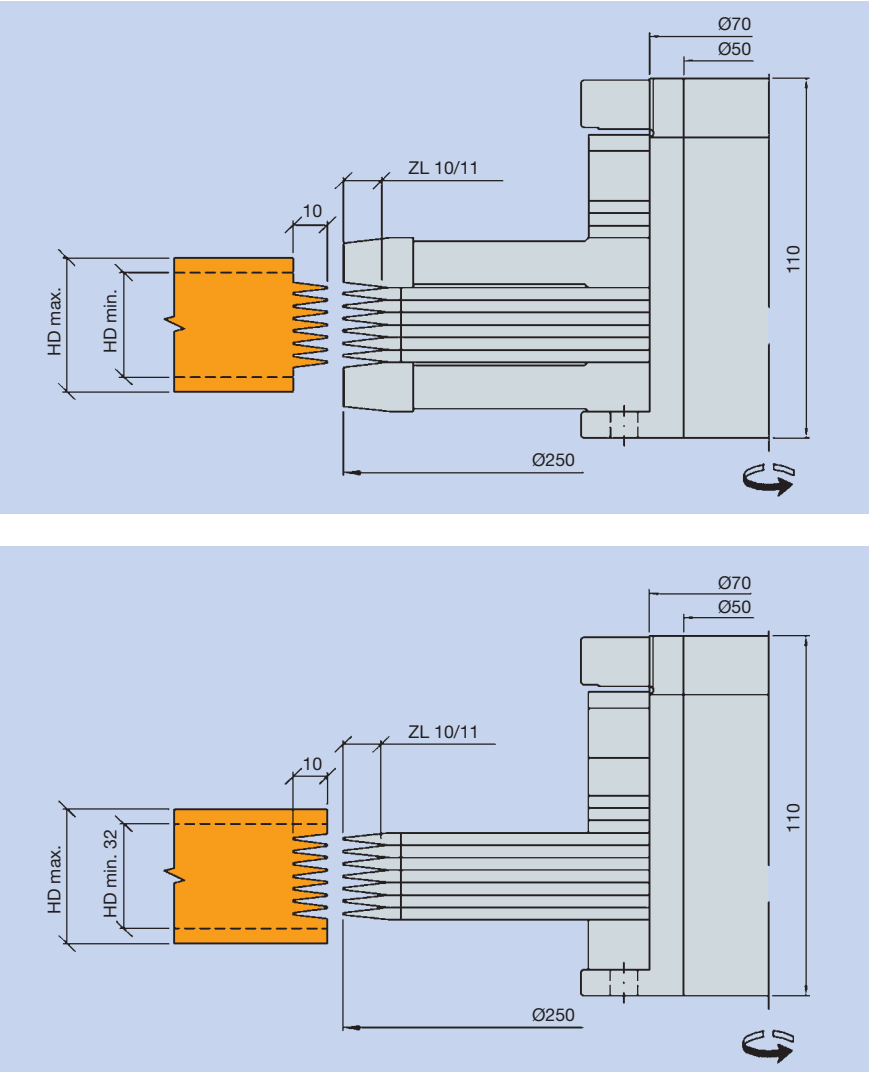
High-performance mini finger joint cutter. Jointing with shoulder cutters.



Finger jointing – with and without shoulder cutters.

HW disc cutter – mini finger profile
This is a tool frequently used on smaller finger joint machines. The number of cutters and the cutter pitch determines the cutting width. Wood thicknesses of between 15 mm and 100 mm, and in special cases up to 150 mm, are possible. All profiles are possible – continuous joint, staggered shoulders, in-line shoulders either at aligned mid joint or to one side.
Tungsten HW tipped cutters are ideal for narrow strips with shoulder cutters from 12 mm or for producing wider strips subsequently split after gluing and pressing.

They can also be used for jointing abrasive hardwoods with or without shoulder cutters. The cutting width is set by the pitch and up to 150 mm is possible. A hydro clamping sleeve is recommended for wood thicknesses above 80 mm to guarantee the accuracy of the profile. When resharpening, the individual cutters must be resharpened to exactly the same cutting circle diameter.

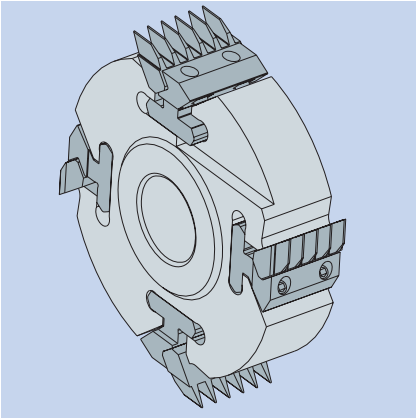


Mini finger joint disc cuttersets for jointing with shoulders cutters.

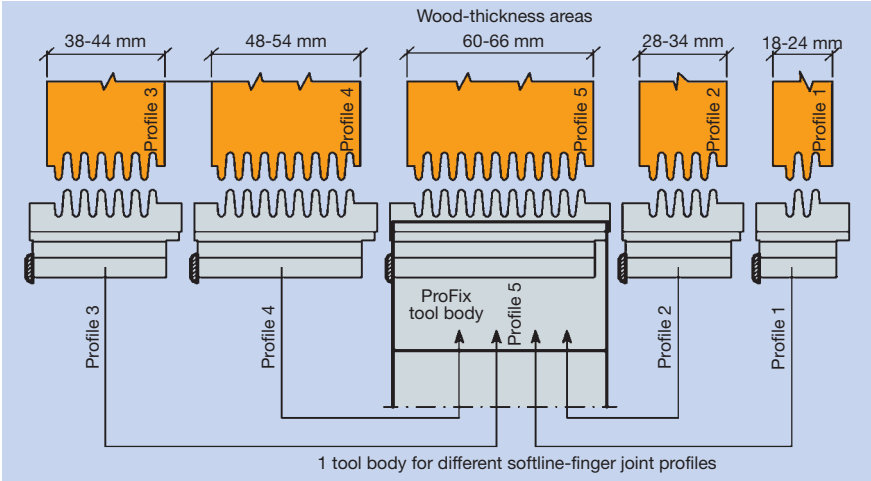
ProFix Plus/ProFix F
HW-mini finger jointing cutterheads with resharpenable knives

ProFix Plus – mini finger joint cutterhead.

ProFix Plus
This flexible and variable finger joint tool is suited for both hardwood and softwood. All standard finger profiles and special profiles can be produced with this Leitz tooling system. Economic efficiency is of the greatest importance. The resharpenable ProFix tool system guarantees constant profile and constant diameter to the last sharpen of the Profix finger joint knives. No machine adjustment is necessary after resharpening so no machine resetting time. The Profix knives are easy to change without the need for any special tools or gauges; the tools are quickly ready for use after resharpening or a product change. Special grades of carbide (HW) are available for specific workpiece materials e.g. OSB boards.



ProFix F – mini finger joint cutterhead; integrated knife-clamping.



ProFix F
The F means flexible. In ProFix-F the Profix knife clamping screw is in the knife, so the axial knife position can be adjusted. ProFix-F can make any profile with shoulder cutters for cutting widths between 16 mm and 80 mm; it is ideal for decorative finger joint profiles. As the full profile is machined with a single ProFix-knife the joint profile remains parallel. Profix eliminates the deflection to the fingers as the cutter leaves the workpiece.
The Leitz ProFix-F system with changeable glue joint profile knives is noted for its flexibility. Profix-F minimises the machine down time, eliminates adjustment to the cut-off saw so gives high machine efficiency. Planned changes, e.g. different wood thicknesses, are simple. Any correction to the joint for the different types of wood is simply an adjustment to the axial position of the knives. Tight fitting soft line profiles are now possible with the Leitz ProFix-F system. Narrow strips, often split from thicker strips after gluing, can be easily made with attractive visible glue joint profiles. ProFix-F can make special customer glue joint profiles in different designs and widths. The right choice of tooling – governed by the product and machine configuration – increases the production efficiency and the machining process. As the machines are often linked as production lines, any machine downtime can cause a significant reduction in productivity. Productivity is increased with the correct choice of the cutting material and the right tools for high performance finger joint machines.

3. Machining panels

Since the launch of chipboard, further developments have created a range of panel wood products with different physical characteristics. All are wood based and by processing the natural wood in different ways, the wood has been changed and acquired new material characteristics suitable for the specific applications.

Chipboard is still the most widely used material, but today it is closely followed by MDF (Medium Density Fibreboard), which is becoming increasingly important. Others are HDF boards (High Density Fibreboard) and OSB boards (Oriented Strand Board).

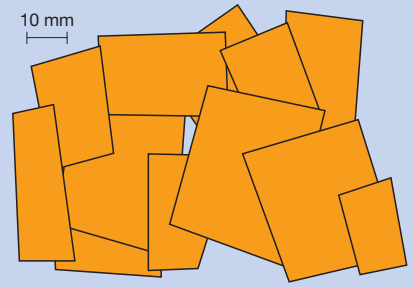
Additionally there are the wood materials frequently used in the USA under the name “Engineering Wood-Products” for building construction and interior finish. These include conventional chipboards as well as flake board, wafer board, OSB or composite products like ComPly. As well being used as panels, some are moulded or used as construction elements such as weight-bearing pillars or beams.

Most frequently the boards are either coated or painted. The oldest form of coating is real wood veneer, but today it has been overtaken by melamine and low resin impregnated thin paper foils.

The board material characteristics have been developed specifically for the intended application. Today chipboard, MDF and fibreboard have many uses in modern building construction, in interior finishing and in furniture production. A further important use has been in the development of flooring products where it is used as the core material for parquet and laminate flooring. Glued waterproof chipboards and OSB boards have an important role in interior finishes such as floor substructures and components in walling.

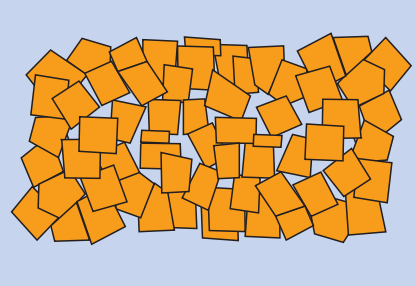
Chipboard is made on continuous production lines. Hogging tools and saws are used to size and finish size the boards as they exit the press.

The board when made is uncoated and coated later usually at a finishing plant which makes the end product.

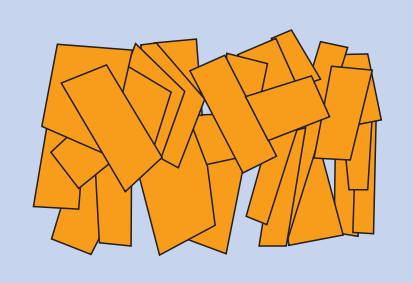


Waferboard

OSB



Type H



Flakeboard

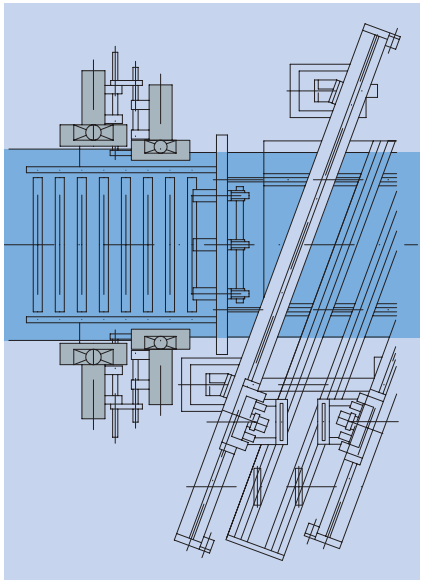
Chip structures for chipboard for construction uses.

Edging

Cutting the raw board to the finished size i.e. removing any irregular residual material from the long and cross edges, can either be done either immediately after the press whilst the board is still hot, or later after it leaves the cooling/curing station. Tungsten carbide tipped segmental hoggers are usually used to machine the long and cross edges. The raw chipboard temperature and the resin curing time effect for the cut result. The not yet fully hardened glue of warm boards has a tendency to stick to the sawblade and hogger body. The sawblade tip should have a large cutting edge projection, kerfs for the sawblade tip and sawblade body of 4.4 mm and 2.8 or 3.0 mm respectively.

Leitz recommend a segmental hogger for this process, and the hoggers can have their cutting width extended up to 60 mm. Each hogger body extension has 6 hogger segments to reduce the cutting pressure. These hoggers can be used on both the length and cross hogging stations.

3. Machining panels



Sizing station (Siempelkamp).

Hogger set for sizing station.

Hogger set for finishing station.

Leitz recommends a specially developed segmental hogger for the finish cut that gives an excellent edge quality. The hogger has both a sizing and finish cut sawblade and a hogger body with Z12 teeth per segment.

Cutting to size

If the chipboard plant delivers the boards to customer specified dimensions, the boards are cut to size on a large panel saws. Because of the large book height and the demand for the maximum feed speed, and hence power, optimised circular sawblades are used. With smaller diameters the choices are, apart from the standard design of sawblades, noise reduced sawblades models AS-Opticut UT (irregular pitched teeth) and AS-AS-low noise with foil. The tooth shapes can be WZ (alternate top bevel teeth), FZ/TR (flat/ trapezoidal teeth) or WZ/FA (bevelled alternate top bevel teeth). To absorb the cutting forces and the strain of constant use the teeth are brazed to thicker stable sawblade bodies, which can, due to the necessary lateral projection, increase the cutting width (kerf) by up to 1 mm. Cooling elements can improve the chip removal in large book heights but may reduce the stability of the sawblade body.

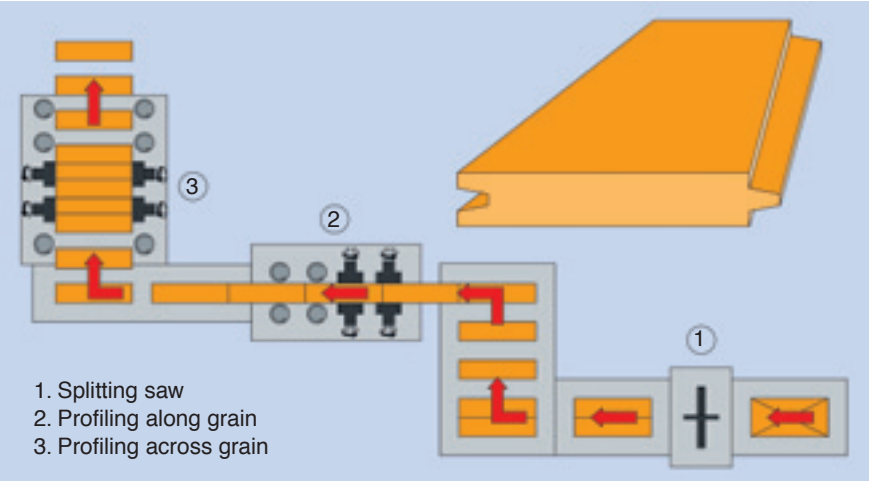
The size of the sawblade gullet determines the feed speed. The size of the gullet is reduced during resharpening, and with it the potential feed speed. This can be up to 40 % over the life of the sawblade.
(See also chapter 4.2 machining coated particle boards).

Profiling

Profiling the boards on the narrow edge is usually after coating and depends on the end product, e.g. furniture, door linings, ceiling or floor panels.

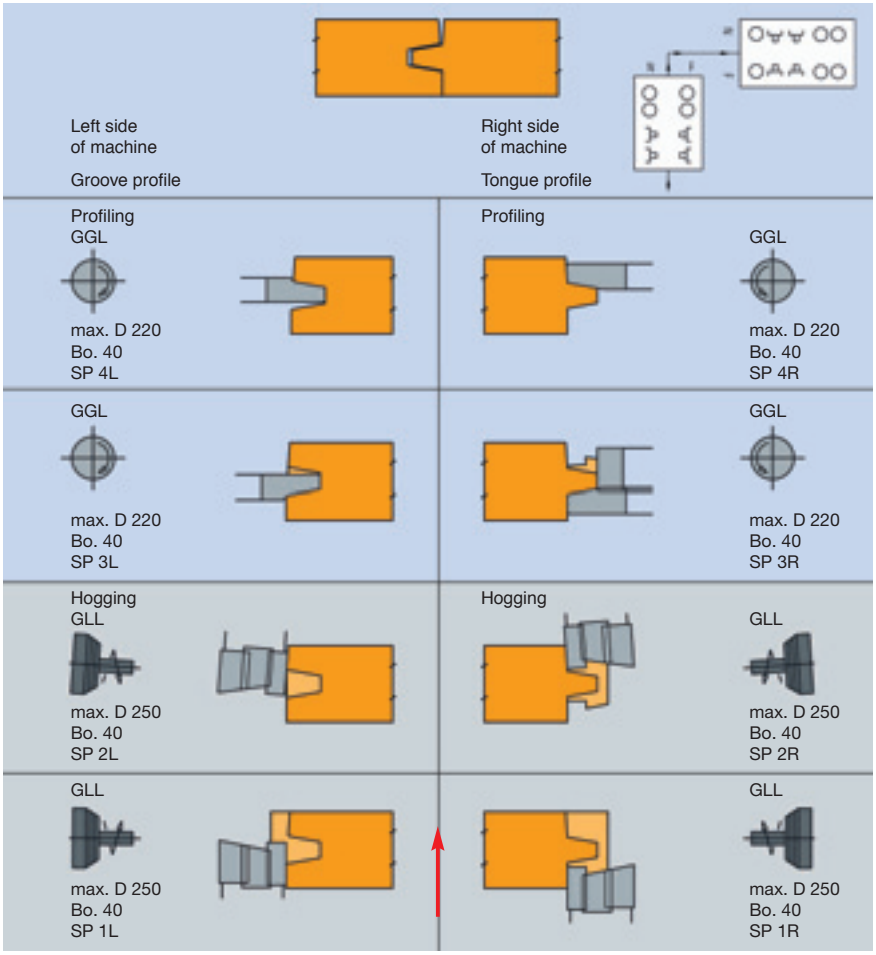
It is usual for uncoated boards – chipboards and OSB boards, specifically the moisture resistant grades – to be delivered by the board manufacturer ready for use as either building or floorboards in standard sizes with tongue and groove profiles.
The boards are profiled on double end tenoners in a series of steps on the length and cross edges.
The diagrams on the right side show linked production lines profiling OSB in a sequence of tools on 4 stations per side.

Chipboard and OSB tongue & groove panel production line
Basic schedule of an OSB tongue & groove and a panel tongue & groove production line.



Linked production line for tongue & groove profiles of chipboard.

Machine: Length profile, v_f: 80 m/min
OSB tongue and groove machining, machine 1: profiling along grain, 4-spindle-concept, thickness 12-34 mm, v_f: 80 m/min



Tongue and groove profiling of OSB-panels.

4.1 Solid wood furniture

Our ancestors built their furniture entirely from solid wood, but today radical changes have occurred in both product construction and manufacturing processes. Beside “classical” designs in solid timber – where the product is made entirely from solid wood components – there are more and more mixed constructions combining solid wood and panel materials.

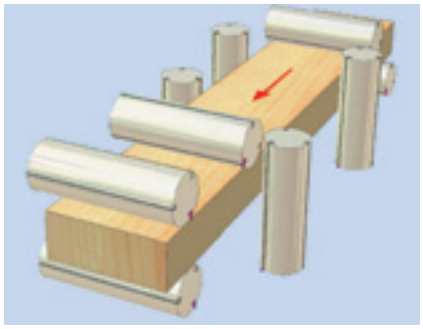
Today solid wood is a premium material and used for manufacturing chairs, benches and other forms of seating. It is also used in cabinets – the body and doors are from solid wood either as single piece or in the traditional design of a frame and raised panels; solid wood is also popular in combinations with glass or metal as an exclusive material.

Solid wood furniture manufacture today is very different from the traditional manufacturing methods of the past.

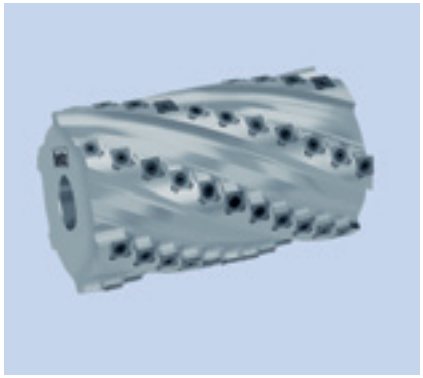
Today furniture designs and layouts are shown to potential customers by 3D-pictures, the order is processed on line by the internet, and the order creates the data to operate the CNC-machines, the flexible production centres that will make the product.

Typical machines and technologies in solid wood furniture production are four-sided moulders, double-end tenoners and increasingly, CNC machining centres.

Solid wood profiled mouldings.



Machining plan four-sided planer.



HeliPlan planer head for pre-planning.

1) Four-sided planing/moulding machines
Machines, commonly referred to as 4-side moulders, are used both to plane the four sides of the workpieces as a first step in the production process and to machine profiles on the workpiece.

Compared to the traditional way of planning, thicknessing and profiling the workpiece on different machines as separate operations, doing all on a 4-side moulder improves the workpiece quality, both surface quality and dimensional accuracy. It is also considerable more economical.

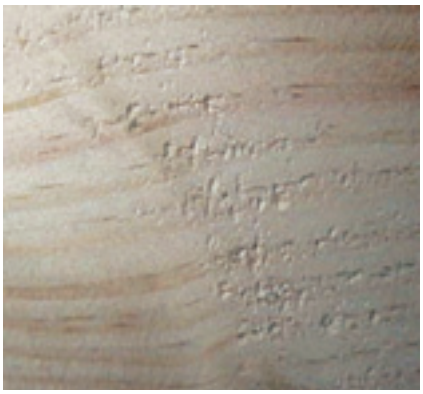
Surfacing/Pre-planning
When surface planing workpieces mechanically, large chip removal may be required because of the dimensions of the workpiece. This requires tooling solutions designed for this application.

The Leitz HeliPlan planer head, with spiral cutting edges, has advantages over conventional tools with straight cutting edges.

It is suitable for nearly all types of wood and gives significantly less tear out on timber surfaces with difficult grain structures and knots.

Pre-planning/Finish planning
Machines with more than 4 spindles make it possible to optimise the machining process by dividing the processing steps between pre-planing and finish-planing.

This also allows the tools to be optimised for each processing step benefiting both the product quality and reducing the machining costs.



Workpiece surface finish planed without pre-planing.

Workpiece surface with pre-planing and finish planing.

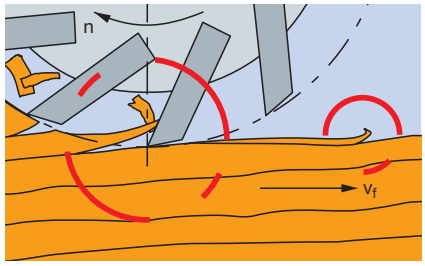
CentroStar planerhead.

Pre-planing
Tools for a high chip removal, low cutting force and very long runt time, for example Leitz HeliPlan.

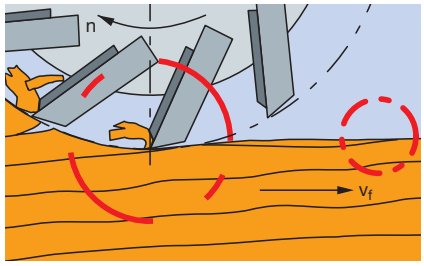
Finish planing
Finish planning tools must produce an excellent surface quality for gluing or lacquered. The material removal should be between (0.5-0.8mm). The Leitz-VariPlan and CentroStar designs are excellent finish planing tools. The CentroStar planing knife has an integrated chip breaker.

Profiling
Depending on the type of wood, the quantity required and the machine configuration, Leitz offers custom-made profiling solutions for any requirement. The cut quality and performance time can be improved by using the correct tungsten carbide quality as the cutting edge material. HS is seldom used in volume solid wood furniture manufacture because of the high cutting edge wear and so low run time.

When machining brittle woods or woods that split easily, tools with integrated chip breakers have proved themselves: The chip made by the main cutting edge is broken – as on a hand plane – so reducing pre-splitting at the surface.



A) solid wood processing without chip breaker.



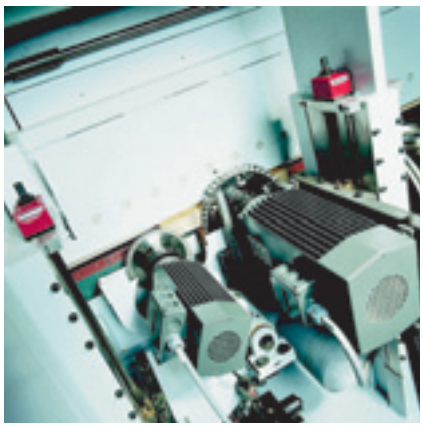
B) solid wood processing with chip breaker.

Tool Clamping
Much is expected of the machines today. Flexibility, as well as high machined surface quality and high productivity are expected. Here the new HSK interface between tool and spindle offers significant benefits. The improved concentricity and higher balance quality of the HSK-seating gives greater productivity at a higher feed speed. Product quality also improves as the higher cutting speeds are now suited for machining solid wood (70-80 m/s).

2) Double-end tenoner
Double-end tenoners processing solid wood consist of two parallel and adjustable profiling machines. They are used, depending on the configuration, for processing solid wood parts such as door panels, and end grain profiles such as slot and tenons. With special guides or

Tool clamping with HSK.

HeliPlan planerhead with HSK interface.



Sizing with scoring-hogging.

Contour shaping with edge rounding device.

CNC controlled aggregates it is possible to produce shaped contours, corner rounding, covings etc.

Cabinet door frame with raised panel.

Sizing
The first step on a double end tenoner is sizing the workpiece with hoggers. Frequently both the length and cross cutting operations are done on the same machine so a combination of scoring: hogging is used. When cutting across the grain, a jump scoring unit cutting with the feed is needed to work with the hogger cutting against the feed otherwise the hogger will create break out when leaving the workpiece.

Profiling
A combination of with-feed and against-feed machining is used to eliminate breakout when profiling. The tool profiling against the feed does most of the machining. The tool machining with the feed jumps in between 3-10 cm from the end of the workpiece and about 0,1 mm deeper than the tool machining against feed to prevent the second tool touching the already profiled surface.

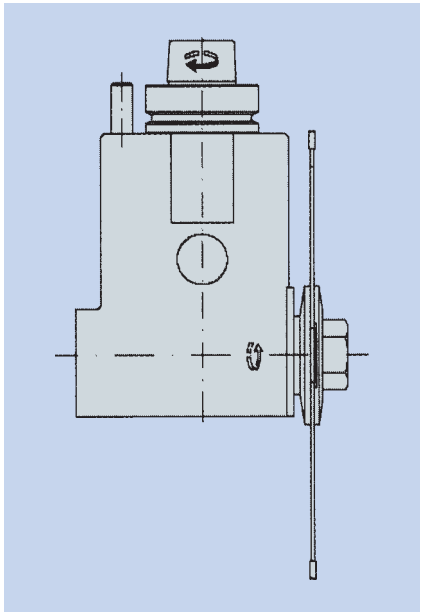
Profiling may be supplemented by, for example, a corner rounding device which uses tools, guided by template and ring fences, to shape the leading and trailing edges of the workpiece.

Today, for greater flexibility, easy set-up and economy, HSK interfaces as used on CNC-machining centres are used on double end tenoners. The HSK interfaces can be carried in automatic tool changers.

3) CNC machining centres
CNC machining centres are now widely used in furniture production. As well as the flexibility in what they can produce, they can fully machine a single part in one set up. Besides the rationalisation from grouping the single processing steps into one by eliminating non-productive time (transport and set-up), the product quality is improved – machined finish, dimension and profile accuracy.

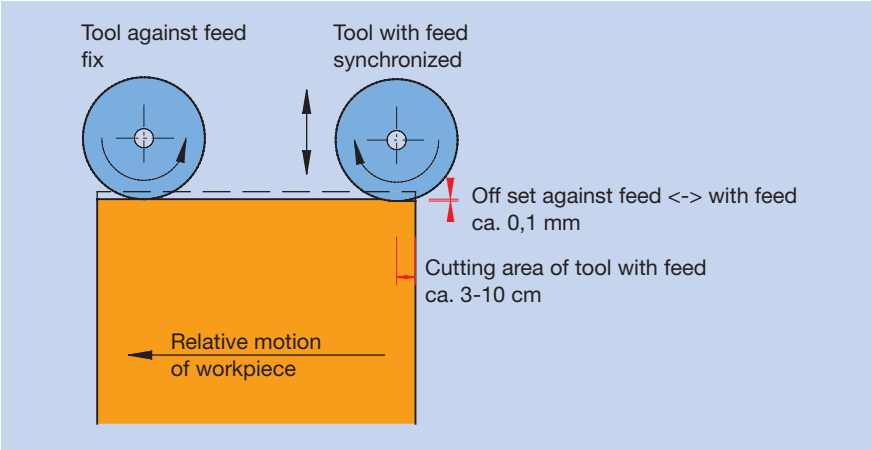
Sizing
Sizing is the first workpiece process step.

CNC machining centre with automatic tool changer (HSK).



Aggregate with splitting saw.

Alternative top bevel teeth.


Tool against feed fix
Tool with feed synchronized
Off set against feed <-> with feed ca. 0,1 mm
Cutting area of tool with feed ca. 3-10 cm
Relative motion of workpiece

Sizing can be either by saws or cutters, depending on the workpiece geometry and the machine capability.

Saws can be carried on saw aggregates for straight and mitre cuts or angled aggregate.

Circular sawblades with the correct tooth geometry are recommended – alternate top bevel teeth are best as the sawing operation is both along and across the grain. It is possible to reduce noise levels, improve the cut quality and extend the tool life by using saws with irregular pitched teeth. Feed speeds of up to 25 m/min are possible depending on the material and the workpiece thickness.

Routers
Routers mounted on the main spindle are used for both straight and curved roughing cuts.

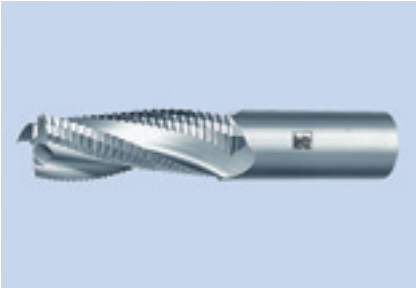
Solid tungsten carbide roughing cutters with a spiral cutting action and diameters between 16 and 25 mm have proved ideal for processing solid wood. These routers with serrated spiral cutting edges give virtually tear-out free edges at feed speeds up to 20 m/min.

Tools shrunk into ThermoGrip chucks can run at higher feed speeds and have increased tool life because of the reduced clamping eccentricity and the greater stiffness of a one-piece tool.

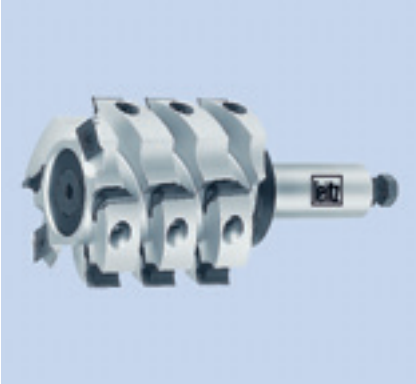
Copy-shaping cutterheads carried by the main spindle are ideal for straight cuts, shaped cuts and hogging waste material.

Copy-shaping cutterheads with spiral arranged tungsten carbide turn-blades can be used as sizing tools. These tools – diameters between 80-125 mm – hog any residual waste that may interfere with subsequent machining operations into chips. This tool is also ideal for pre-relieving deep profiles prior to the finish profile tool.

Profiling
Workpiece profiling can be for example machining grooves, rebates, panel raised profiles, profiles and counter profiles. Here the objective is to achieve a good surface quality at a high feed speed, with a low power input and a low cutting pressure.



Solid HW spiral roughing router cutter.



Copy-shaping cutterhead for sizing.

Router cutter with cylindrical shank.

ProfilCut cutterhead.

The workpiece vacuum clamping or the tool clamping sets the limits – these may not hold the workpiece or tool rigidly enough against the cutting pressure – creating a cut quality below expectations.

The right choice of tool and program make it possible to increase the machine performance and workpiece quality significantly.

The tools used depend on the shape of the workpiece and the machine aggregates.

Profile routers mounted on the main spindle are used for both straight and curved shapes.

Small tools with shanks clamped either in collet chucks or ThermoGrip chucks can be used on all CNC machining centres or CNC routers.

The choice of cutting material, for example different grades of tungsten carbide (HW) or polycrystalline diamond (DP), depends on the material or production volume. Because of the physical characteristics of diamond, diamonds tipped tools are recommended for hardwoods without loose elements (e.g. loose knots). HS is seldom used in solid furniture manufacturing on CNC machining centres because of the high cutting edge wear rate.

Turnblade tools mounted on the main spindle or on aggregates.

The feature of these tools is that there is no change to the profile or diameter when replacing the cutting edges. The use of mirror-finished tungsten carbide cutting edges guarantees an excellent machined quality and long tool life. Combination tooling-sets are an interesting concept as the different profiles e.g. profile and counter profiles, are mounted on the same arbor. The profiles are stacked and selected by axial spindle adjustment.

This optimises the process by eliminating a tool change and reduces the space required in the magazine.

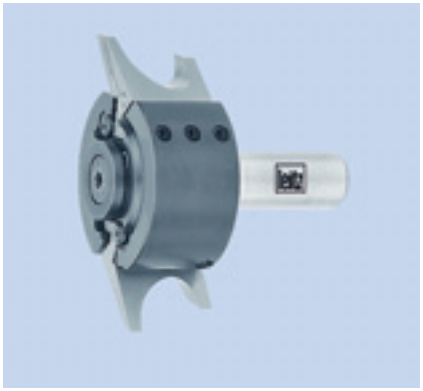
Tools with re-sharpenable knifes mounted in the main spindle either as a single tool or a tooling set.

Leitz ProFix offers a very flexible and low running cost solution for large volume production. The re-sharpenable profile knives have both a constant profile and a constant diameter. Changing the profile requires only changing of the profile knives, the tool body stays the same. This reduces the purchase costs and the tool stock. Also, the same profile knives can be used on different machines in different tool bodies.

The correct choice of program path guarantees tear-out free machined results, even when profiling solid wood across the grain.

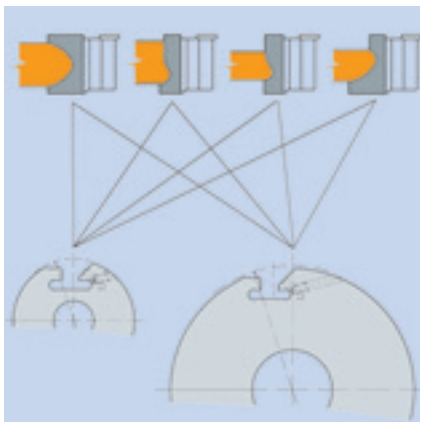
With the correct cutting strategy, profiles can be machined with tools running in one rotation only. Right and left hand rotation tools are not required, again saving tooling costs, tool stock and magazine space.

Drilling
Different designs of drills are used to achieve excellent, tear-out free holes to a high quality and dimensional accuracy at a high feed speed without the

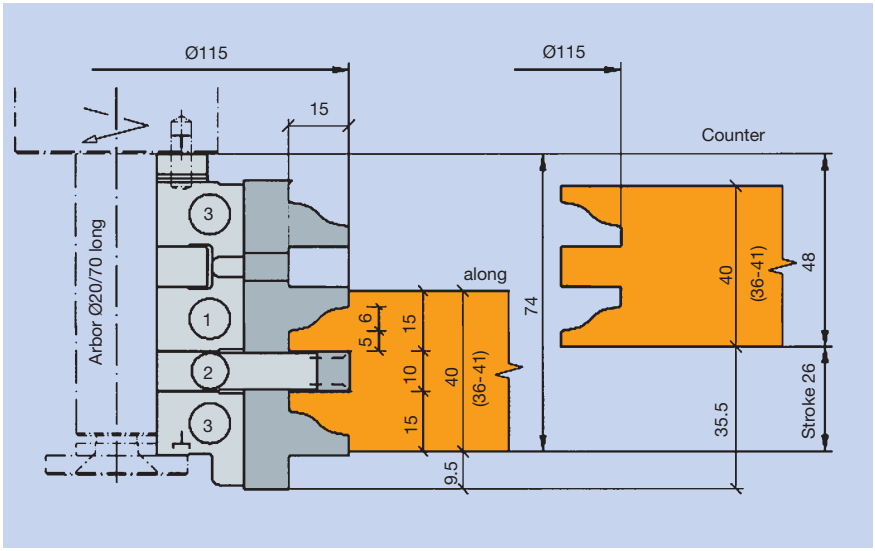


ProFix Universal profile cutterhead.

ProFix Counter profile cutterhead.



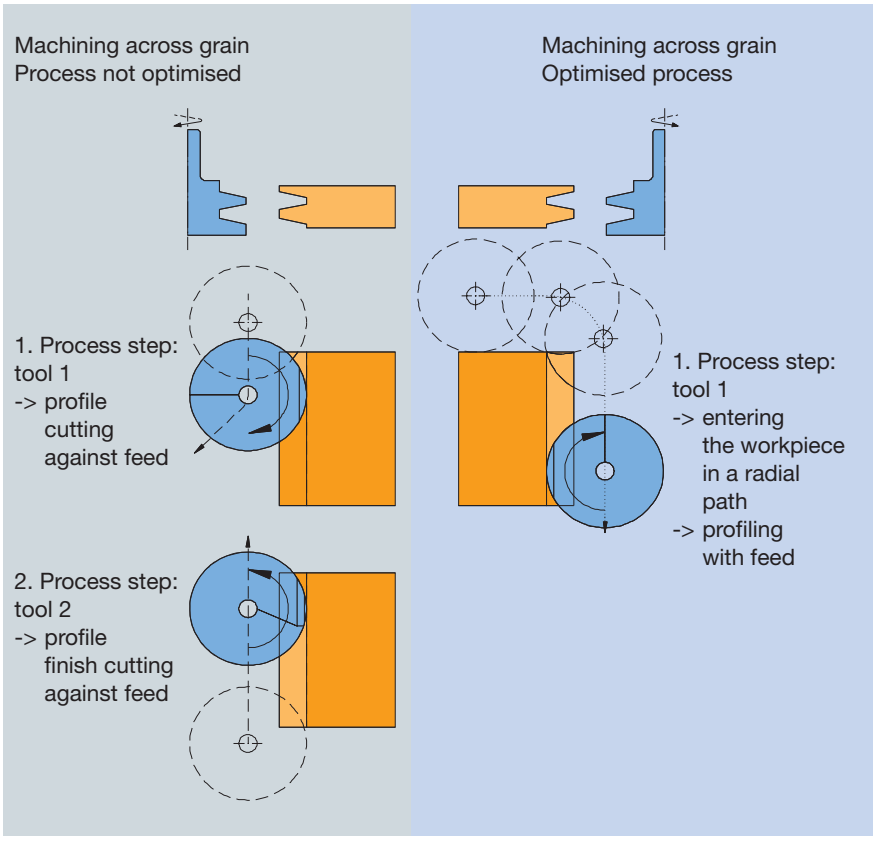
ProFix modular system.



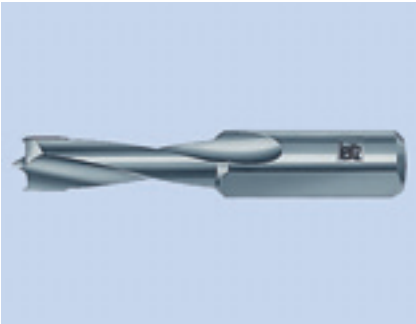
Combination tooling-set for profile and counter profiles.

need for a clearing stroke on deep holes. A wide range of dowel drills, through hole drills, stepped drills and hinge boring bits is available giving the best results in all types of solid wood.

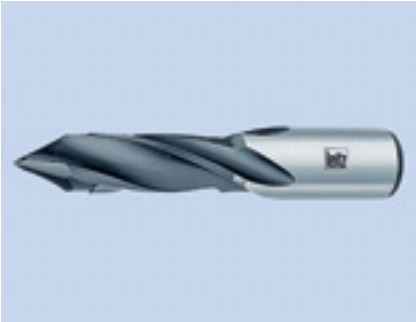
As a rule, all the drills used on automatic multiple drill aggregates or single drill aggregates on point-to-point boring machines should have the same overall length (GL).



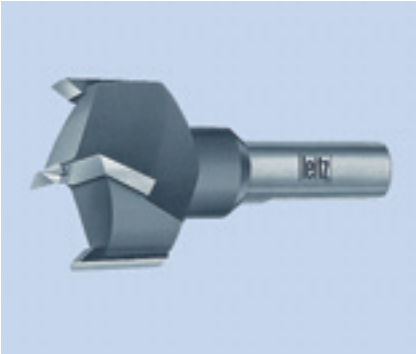
Rationalisation through optimised production on machining centres.



Dowel drill bit.



Through hole drill bit.



Hinge boring bit.

Solid carbide drill bit.

As well as the traditional carbide tipped drills, more and more solid carbide bits are now used. The advantages of solid carbide drills are the large resharpening area and the stiff, rigid construction, which prevents the bits from bending under harsh working conditions.

Knowledge
Besides selecting the right tools, important factors for the success are:

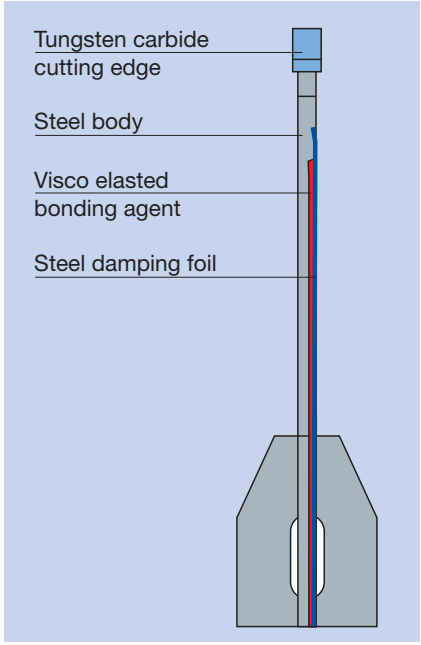
– Product specific and rigid workpiece clamping. Poorly clamped and vibrating workpieces result in poor hole quality and reduced tool performance times.

– The right interface between the tool and machine makes it possible to use the full potential of the machine. The modern interface like Leitz Thermo-Grip makes it possible to increase the quality, speed and performance of the process.

– Short tool changing cycles – quick change drill chucks reduce the set-up time, operating costs and increase the machine line productivity.

The program is an underestimated factor in the success or failure of the machining process. The right processing sequence – clever entry and exit paths, climb or power cut, RPM, feed speed – set the result as seen on the finished workpiece. The Leitz R & D department has the equipment to test different solutions and a long experience in woodworking. Leitz, your tooling partner, can help you with all aspects of the application.

Since the 1950's furniture made from wood based man-made materials has literally conquered the world. This success was a combination of attractive pricing and widespread availability of wood based panel materials. Despite initial consumer prejudice against the new materials – chipboard and MDF – the technical advantages of dimensional stability of panel furniture compared to solid wood furniture created wide acceptance for furniture made from these wood based man-made materials. Today environmental arguments are even more important. High quality timber is scarce and becoming hard to source. The possibilities of using waste timber, yield maximisation and recycling make wood based panel materials indispensable and ensure further future developments. Development of wood based panels stimulated the development of tooling solutions suitable for processing these new materials economically. Increased wear and damage from mineral impurities (sand, stones, pebbles, etc), metal inclusions (nuts, bolts, staples, nails, etc) and high abrasion from the glue content of the panels demanded tougher and harder cutting materials. Tungsten carbide tipped tools were developed alongside these man-made materials. At the same time the traditional craft techniques of cabinetmakers and carpenters became technology driven by these new materials, new hardware/fittings and new machining concepts. Price driven market forces plus the need for increased productivity accelerated the technological developments.



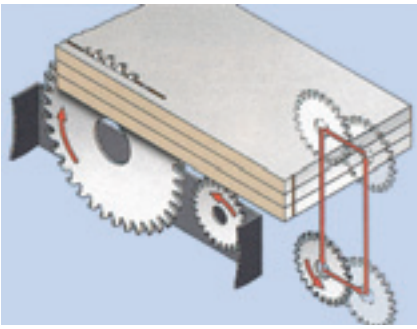
MDF-panel edge and AS-foil sawblade.

MDF-surface with/without teeth mark.

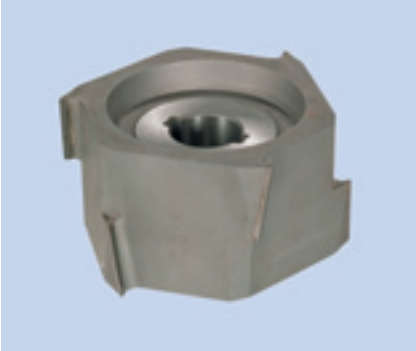
Manufacturing panel furniture requires three basic processing steps:
1.) panel sizing
2.) edge banding
3.) drilling

Typical machines used for these operations in modern furniture factories are panel saws (beam saws), edge banding machines (single or double sided, possibly with additional sizing spindles), double end tenoners (usually double sided edge banding lines with profiling), multi-boring machines (possibly through feed lines) and today, in growing numbers, CNC machining centers. There are two manufacturing methods when using beam saws. Machines with sawblade diameters of 300-450 mm are used for small/medium batch quantity panel production. Single panels or small stacks are cut to a finish size for subsequent edging without further sizing. For high quality and perfectly square panels, this method requires properly cured and stabilised panels, free from internal stresses.

Beam saws are better than table saws as they precisely position and firmly clamp the panel whilst cutting, and can cut of stacks of panels. The wider kerf sawblade means a more rigid sawblade body so higher feed speeds are possible despite the higher cutting forces. Leitz sawblades for such machines are optimized for their cut quality and run time but the different materials need different tooth shapes. The best tooth shapes for cutting plastic laminated panel materials e.g. melamine faced chipboards; HPL laminated MDF; etc. are square/trapezoidal (FZ/TR), trapezoidal/trapezoidal (TR/TR) and alternate top bevel with chamfer (WZ/FA). Alternate top bevel saw blades (WZ) are normally used to cut raw panel materials, panels without coatings. Leitz AS-low noise foil laminated sawblades meet the high quality requirements and have many benefits. A specially designed steel damping foil is cold bonded to the recessed saw body on these sawblades. Leitz AS-low noise laminated foil sawblades are up to 10 dB quieter than standard sawblades – 10 dB less means halving the noise level. The damping foil significantly reduces sawblade vibrations, resulting in the highest cut quality.



Beam saw with post forming scoring sawblade.



Conventional PKD-jointing cutter.

Noise-reduced PKD-jointing cutter in symmetrical design.

PKD-jointing cutter in unsymmetrical design.

Beam saw scoring sawblades usually have an alternate top bevel conical tooth shape (WZ/KON). The conical tooth shape allows quick and easy adjustment when matching the kerf of the scoring sawblade to that of the main sawblade. For tear free sizing cuts on already edged panel materials (e.g. soft formed/post formed panels) beam saws must be equipped with a special post forming scoring sawblades. These “rising” or “jumping” post forming scoring sawblades prevent possible chipping and break-out to the laminated surfaces by the main sawblade. Post forming scoring sawblades usually have square (FZ) or alternate top bevel (WZ) shaped teeth. It is essential the kerf of main sawblade and the post forming scoring sawblade match exactly. Main and post forming scoring sawblades should always be purchased and serviced as sets to ensure the kerfs remain matched.

Beam saws are designed to cut high panel stacks heights at high feed speeds in large volume production. The sawblades on these machines have diameters of 570 mm or greater. The long cutting arc has implications on the design of the gullet size and tooth shape to reduce the cutting forces when cutting high panel stacks at high feed speeds.

These machines are normally used for rough sizing cuts in wood based panels. The objective when designing suitable panel sizing sawblades is to maximize the run time rather than the cut quality. The standard available tooth shapes are alternate top bevel [WZ] or square/trapezoidal [FZ/TR]. As the size of the tungsten carbide saw teeth is reduced at each sharpening it reduces the gullet volume making it necessary to reduce the feed speed by up to 40 %.

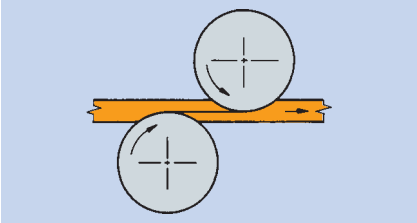
Edge banding machines have an important role in producing panel furniture. Achievable feed speed ranges are between 20 to 32 m/min, suitable for batch and small series production volumes. These machines are designed for either single sided or double sided processing and often feature optional sizing jointing cutters. A series of cutters follow the application of the edge banding. These are (in consecutive order): trim saws to cut the edging material accurately to length, rough and fine trimming cutters, optional radius trimming units for either round or chamfered edge profiles, tracing copy shaping, scraper knifes, profile sanding and buffing to give the required edge finish quality on plastic, veneer or solid wood edging.

The sizing section has two jointing cutters. The first jointing cutter cuts with the feed, the second cuts against the feed. The tool cutting with the feed machines approximately 30 mm of material at the end of the panel. This tool jumps in and out of the cut by pneumatic cylinders. The depth of cut of the tool machining with the feed is marginally deeper than that of the tool machining against the feed. This prevents the cutting pressure of the tool machining against the feed chipping or breaking off the edge banding already glued to the panel’s transverse edge.

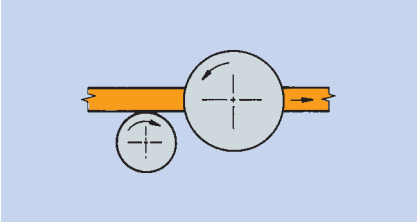
The sizing or jointing cutters are often positioned outside the machine enclosure and covered only by standard dust extraction hoods. So noisy, so Leitz has developed low noise tooling that reduces the noise by up to 8 dB (A). These tools, depending on the material, are designed to machine an overhang of up to 5 mm in one step.

As well as reducing noise levels to a minimum, these jointing cutters have alternate shear angle geometry for optimum cut quality. They are available

in either symmetrical or asymmetrical design. Diamond symmetrical design cutters have spherical cutting edges to create a slightly concave surface on the edge of the panel. To achieve a symmetrical surface the tool horizontal centre line must always be adjusted to the horizontal centre line of the panel. The concave profile improves the adhesion of the edge banding. Fibres, which might protrude from the core of the panel, no longer interfere with the gluing process. When machining a wide range of panel thicknesses, tools should be designated for each panel thickness. The cutting edges wear more at the top and bottom panel lamination and are frequently damaged by the panel core. Tools suffering such wear and tear no longer give satisfactory cutting results in the lamination layer of thinner panel materials.



Double-hogging.



Scoring-hogging.

The bottom cutting edges of asymmetric diamond jointing cutters have up-shear, all the other cutting edges have down-shear. This eliminates the need to adjust the tool spindle vertically when machining different panel thicknesses. The asymmetric version however does not give a concave surface. An asymmetric low noise diamond jointing cutter is positioned so that the upper portion of the bottom cutting edge (up-shear) meets the bottom face of the workpiece on the machine track. Adjusting the tool vertical upwards as soon as wear to the cutting edge causes chipping to the panel bottom lamination can maximize the tool lifetime. The panel's "good face" should always be face down on the track.

The cutters used on an edge banding machines after the edging is applied are identical to those on double end tenoners, described below.

Double end tenoners (DET) can be considered as two single sided edge banding machines facing each other. The distance between the two machines is adjustable and when adjusted the two sides remain parallel. The type of edge banding material applied to the workpieces determines the achievable feed speed. Feed speeds on DETs range from approximately 20 m/min for solid wood edging lippings and soft forming applications, to around 40 to 60 m/min for plastic edging tapes (PVC; ABS; etc. 2-3mm thick) and up to 120 m/min for thin edging materials such as 0,3-0,4 mm thick melamine edging tape.

The type of adhesive (hot melt glue) used on high-speed DET lines is importance as the edge banding can only be machined if the glue has cured sufficiently to ensure a firm bond between the panel and the edge banding material.

Sizing on DETs is normally with hoggers. New machines are usually equipped with double-hoggers, though a scoring-hogging set up often gives better cutting results on single sided machines and DETs used for both length and cross machining. Scoring-hogging is also recommended for veneer edges or very brittle edging materials.

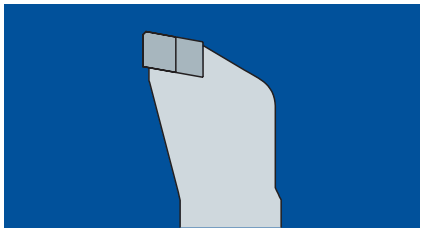
Jump jointing or milling heads should be considered for DETs with double hogging as the first machining station. The jump jointing head cuts against the feed, marginally deeper than the subsequent hoggers, to ensure the double hoggers, usually cutting with the feed, do not break off the edging of already edged panels. Jointing cutter heads with reversible tungsten carbide knives and alternate shear can be used for feed speeds up to 40 m/min.

Diamond tipped low noise jointing cutters are necessary for higher feed

speeds. Adjustable jointing cutters are an economical solution when machining different material thicknesses in larger batches. These adjustable cutters give the maximum tool life and minimum machine down time.

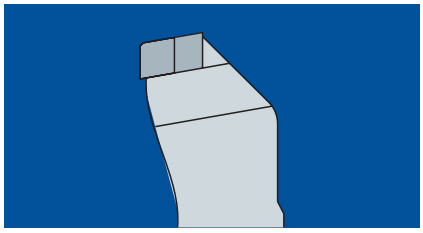
To minimize costs, today most hoggers on DETs are diamond tipped (DP). The “compact-hogger” design concept has proved ideal for DET applications. Compact hoggers have a rigid body giving both a quality cut combined and with a long tool life. Tungsten carbide tipped hoggers (segmented or solid) are used for high risk applications (e.g. machining poor quality panel materials containing impurities and foreign objects) and for machining non-abrasive materials.

The most common tooth shape found on hoggers is square tooth (FZ). However, the rigid tool body design also allows for one side top bevel (ES) tooth shape, suitable for machining panels with soft laminates such as paper or veneer. This design is also known as decreasing top bevel.



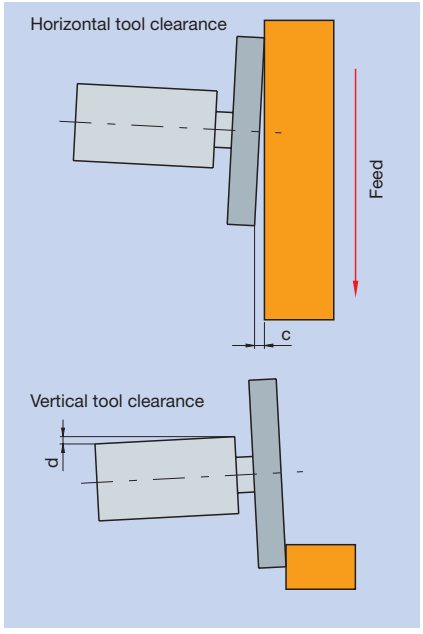
Compact hogger top bevel decreasing – machining along grain.

With an ES tooth shape, the large diameter of a decreasing top bevel hogger enters the material first. The chips cut by the tool move away from the point of tooth entry improving the cut quality. This tooth geometry however creates residual panel pieces that may break off before the hogger can machine them. This can cause damage to the edge of the panel long side when processing the panel short side. Also, when machining wood veneers along the grain and MDF, decreasing top bevel hoggers may create long strips which can block the dust extraction pipes causing machine down time and fires. Leitz has designed hoggers to solve this problem and turn any veneer overhang into chips for removal by the dust extraction.



Compact hogger top bevel increasing – machining across grain.

Hoggers with increasing top bevel are the counter part to hoggers with decreasing top bevel. The top of the tips on these hoggers is angled towards the workpiece giving a shearing cut towards the panel’s edge. The cutting forces press against the edge to be machined. The residual piece created by these types of hoggers is firmly attached to the panel – avoiding break off. Hoggers with increasing top bevel are preferred for the cross cut DET or when machining panels with soft or brittle laminates. When machining wood veneers or MDF, the top of the hogging section on the tool must be in line with the top of the hogger sawblade to avoid the strips mentioned above.



Clearance of hoggers on two planes.

Unlike sawblades, which must be set up parallel to the direction of feed, hoggers are angled towards the material to give a “clearance”. The hogger rotation axis is not perpendicular to the workpiece edge but at a slight angle. This prevents the hogger back cutting and ensures a consistent quality. Despite the rigid tool body the clearance must be small to minimise the axial forces. With sawblade hoggers (hogger body with mounted sawblade) the clearance is 0,2-0,3 mm. For compact hoggers the clearance is usually between 0,3 to 0,5 mm. In scoring-hogging arrangements the hogger clearance creates a slightly concave surface, which improves the bond between the panel and edging material. When double hogging the panel surface becomes slightly convex from the hogger clearance. To counter this, and to insure proper bonding and a high quality on furniture components, slightly tilting the hoggers upward/downward compensates for the effect and leaves a flat or slightly concave surface.

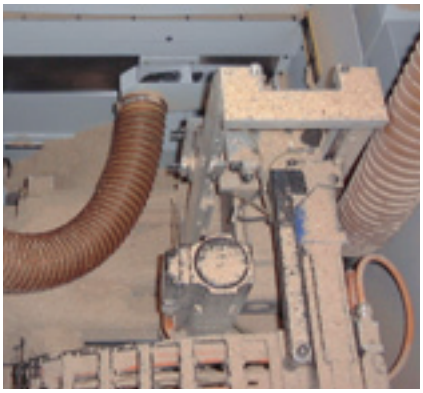
The hogger side clearance is set up with a thickness gauge and should be checked at each tool change. The hogger axis is adjusted in Z-axis to align

it with the core of the panel. The hogger spindle is moved away from the panel. A homogenous workpiece (e.g. MDF) with a straight edge is then fed into the DET. As soon as the panel reaches the hogging station the feed is stopped. The hogger is then slowly moved towards the reference panel until it leaves visible cutter marks. Next the hogger is moved away from the panel and the panel removed from the DET. The height difference within the cutter marks is measured and the hogger clearance adjusted accordingly. The type of machine determines how the hogger clearance is adjusted. New machines often have adjustment screws. Older machines may require loosening the motor mounting plate screws (no more than half way!) and placing thin steel shims between the motor and the mounting plate. The motor mounting screws should firmly secure the shims.

In terms of cutting, hoggers are similar to sawblades. The sharpness of the teeth sets the cut quality and the cutting edges gradually round over as the tool becomes blunt. Wear to the cutting edges increases the cutting pressure and compromises the quality on delicate workpieces such as polyester coated MDF (high gloss finish) even though the tool is not really blunt. Using additional jointing units after the hogging section has proved successful for such applications, So for delicate workpieces only, a post-hogging jointing to a depth of cut of between 0.5 to 1 mm, significantly improves the quality and makes sizing on DETs more economical.

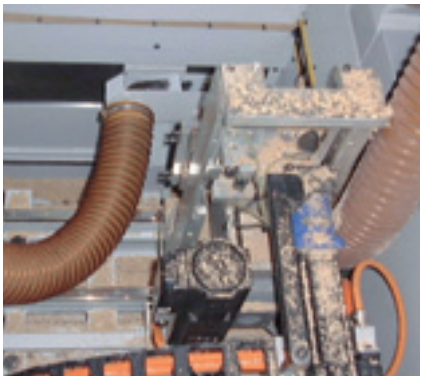
DFC-groove cutter.

Grooving on DETs is a part of the machine's sizing section. The chips created by the grooving sawblade or cutterhead must be removed by the dust extraction. Grooving on DETs is normally with the feed for the best cut quality. This quality is achieved either when grooving vertically in the laminated panel surface or when grooving horizontally in the core of the panel. In chipboard the core consists of relatively large wood chips with a tendency to be pulled out by the tool giving an inferior surface quality. Grooving with the feed solves these quality issues but chip removal when grooving with the feed is difficult. When grooving with the feed the chip flow is in the same direction as the workpiece. This restricts the chip removal with standard dust extraction and often leaves a fair amount of chips in the groove. Leitz DFC – design for groovers has improved this but cannot completely eliminate the problem. Air jets or mechanical scraping devices may be fitted after the grooving station to help remove the chips from the groove. Chip extraction at grooving is a problem; the grooving station may be physically shielded from the other machine sections either by panels or may be in a separate fully enclosed section.



Typical collection of chips in the machine during feed – grooving with conventional groove cutters.

In soft forming and post forming machines, the profiling section follows sizing. In soft forming, a thin edge banding material is glued onto and subsequently wrapped around the pre-profiled panel edge by pressure rollers. On direct post forming through feed lines, a part of the substrate is removed leaving the laminate surface of the pre-laminated panel before the profile is machined This laminate "overhang" is softened with infra-red heaters, glue applied and the overhang wrapped around the profiled edge of the workpiece. Unlike soft formed panels, there is no visible line between the surface and edge lamination on post formed panels.



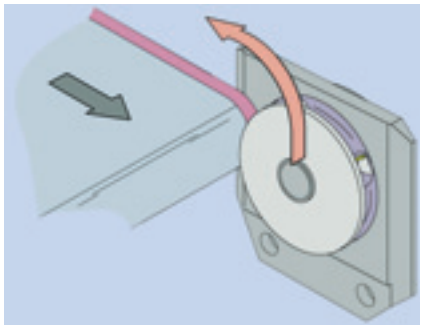
When using the DFC groove cutters most of the chips are collected.

The edge trimming section is usually the first station after gluing and edge application. The trim sawblades cut the edging material precisely to length. Small diameter saw blades with relatively large kerf and one-side-top-bevel tooth shape are used for this task. RPM speeds of more than 12,000 r.p.m.

are common on many machines. To avoid vibration and noise problems the trim sawblades must be designed to match the specific machine.

Leitz AS Opticut UT saw blades work particularly well in edge trimming applications. The irregular pitch of these sawblades creates an interference wave eliminating the whistling noise often a problem with other types of sawblades. Moving aggregates perform the trimming operation. The speed of the trimming aggregates is synchronized to the speed of the workpiece. The conditions during the edge trimming process make it difficult to capture the chips and the cut of parts of edging with the dust extraction system. Until today the trimming sections of the most sophisticated edge banding machines are enclosed and only have a central dust extraction duct.

Most edge banding machines are equipped with rough trimming units as a first stage in the flush trimming/radius trimming process. The roughing trimmers machine the oversized edge banding material to the finish size plus a few tenths of a millimeter. Rough trimming is normally “against the feed”. The rough trimmers operate with tracing wheels and leave an even amount of edging material above the top surface and below the bottom surface of the workpiece. Equalising the excess material gives a higher quality of cut by the subsequent fine trimming units. When machining solid wood edging, the rough trimming units are used for flush trimming and/or beveling. When machining solid wood it is recommended to run the traced aggregates “with the feed” for the best cut quality.



When forming, all workpiece edges are rounded and bevelled.

There are two different methods used to profile edge bandings. The basic profiling or fine trimming method creates a radius or chamfer profile along the top and bottom edge of the edge banding material. In general the profiling or fine trimming tools are guided by tracing wheels to ensure a flush edge when machining the panels to allow for any thickness variation in the panel. It is important the tooling and tracing wheel are precisely adjusted to each other. A reference zero-diameter is often specified for the edge banding profiling and fine trimming tools. Depending on the machine specifications, profiling can be on horizontal, vertical or inclined spindles. Cutter marks are most visible from tools cutting on the circumference and so visible when tooling is used on an inclined spindle. These cutter marks however are easy to remove with scraper knives. Cutter marks created by tools on vertical or horizontal spindles are most visible at the joint between panel surface lamination and the edging material. This is critical as the scraper knives can easily damage the fragile finish of the workpiece.

More sophisticated machines can profile/fine trim the applied edging at the front and rear of the panel vertically (contour-rounding/contour-trimming). This process is by a moving aggregate that traces the workpiece contour. The fact that these aggregates must accelerate/decelerate and match the speed of the moving panels limits the maximum possible machine feed speed to around 50 m/min.

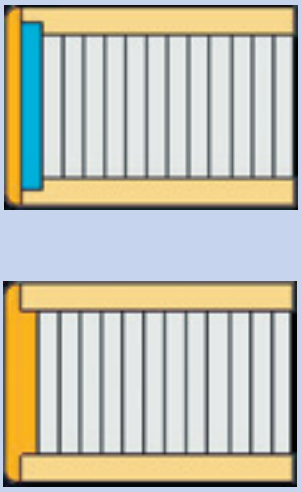
DP-radii cutters for machines with i-System.

i-System tooling is a special design of edge banding tooling. Continuous development of the tooling, dust extraction hoods and machine aggregates has made it possible, for most applications, to achieve a dust collection efficiency of over 95 % and, at the same time, reduce the required airflow volume. On high speed through feed lines with automatic in-feed/out-feed, these tools – with their high efficiency dust removal at lower extraction air volume – save energy costs, significantly improves the component quality

and reduces rejects (chips trapped between the stacked panels can damage the surface laminate). Edge banding machines with i-System tools need less cleaning, are more productive and produce fewer rejects.

The finish surface quality is achieved either in single or multiple steps by a range of processes. Usually scrapers remove the cutter marks created by the profiling tools (radius scraper knives) and remove any excess glue (glue scraper knives). Scraper units are matched to the tracing wheels and must be adjusted with care for a high quality product. Errors in adjustment result in reject panels.

Polypropylene edging has a tendency to “craze” when machined. This “crazing” is visible as fine white lines in the polypropylene. Specially designed scraper knives and heat treatment are used to remove the crazing. Static or oscillating buffing units are also found on edge banding machines. These buffing units use rotating fabric wheels pressed lightly against the edging material to give a smooth finish. Instead of textile buffing wheels, sometimes brushes (with or without abrasive compounds) are used to polish the edges. On special machines sanding units add the final touch to the panel edging.



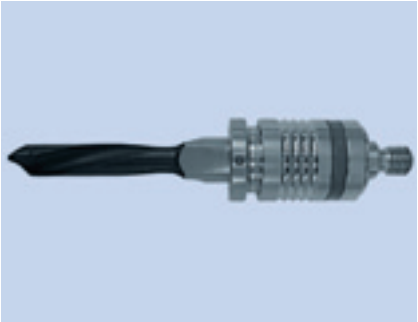
Edges on honeycomb panel material.

There are many customised solutions apart from the standard machining methods. The raw edges of man-made wood based panels are not visually attractive. Wood based panels are hygroscopic; they absorb moisture from the atmosphere. The high porosity of the raw panel edges makes them unsuitable for liquid sealers (e.g. paint or lacquer). Covering the edges of the wood based panels is a necessity if they are to be used for high quality furniture components. A recent alternative to edge banding is edge compression with liquid plastic injection. This technology is costly but significantly improves the panel edge quality.

Honeycomb panels without external frames are another special type of panel requiring customised edging techniques and technologies. The honeycomb core structure prevents traditional edge banding. A possible solution is to rebate the top and bottom lamination of the honeycomb panel and add a matching custom-made edge profile. Alternatively a strip of thick edging material matching the panel thickness is glued between the top and bottom laminations followed by a flush trimming process and an additional edge banding applied in the conventional manner.

Boring machines are used for drilling dowel holes, holes for hardware (fittings & hinges) and for rows of holes for assembly purposes and adjustable shelves. The quality of the holes for shelving, and the edges of these holes, is crucial as these holes are visible. The Leitz range of drills offers solutions to suit all quality requirements. Besides the “standard” range of dowel and through hole drills Leitz has the **“MARATHON”** range for customers who accept nothing but the best at lowest tooling cost per hole. Marathon drills have a special grade of wear resistant tungsten carbide and special cutting edge geometry. This combination of high-tech cutting material and innovative design gives outstanding drilling results and a long tool life. Marathon drills can outperform standard drills by a factor of 10.

Both standard and Marathon drills have a friction reducing surface coating to give an excellent chip flow when drilling deep holes. Additionally the coating is coloured coded to help identify the left-hand (red coating) and right-hand drills (black coating). Leitz solid tungsten carbide drills are a further step



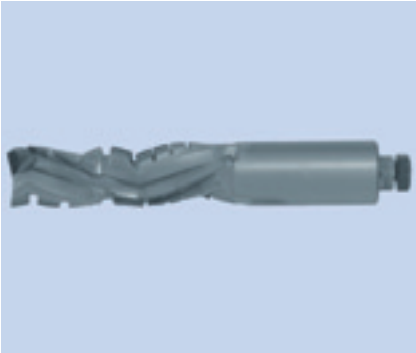
Leitz quick-change system for drills; the right part is fixed in the machine; by pulling on the grooved sleave the drill is released.

ahead. They have the same cutting geometries as the Marathon range drills but because of the rigid physical properties of the **solid tungsten carbide body** these drills do not vibrate, so further extending the tool life and cut quality. The higher rigidity of the solid tungsten carbide drills allows higher RPMs and higher feed speeds than steel bodied drills.

Tool changes on multi-boring machines are time consuming and increase the cost of the components. Leitz quick-change drill chucks help save time and money when changing drilling patterns or when replacing blunt drills. The Leitz quick-change drill chuck is the only one part system on the market. A drill change as quick as a flash – simply out with the old in with the new with Leitz drills fitted with the special high-precision screw for the quick-change chuck.

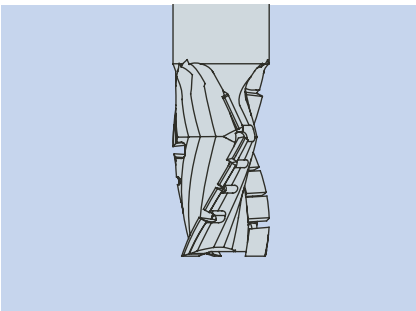
CNC machining centres have become a very popular means of production in the furniture industry in the past decade. CNC machines economical manufacture single components (batch size one) in one machining operation. Sizing, drilling and edging are typical operations on particle boards on CNC machining centres. Machining grooves and edge profiles are frequent operations on MDF panels before spray painting or membrane pressing with a PVC-foil.

Diamond (DP) tipped router cutters have proven highly cost efficient solutions for sizing laminated particle boards. CNC sizing operations are normally performed “against the feed” (right hand tool (RL): clockwise tool rotation – counter clockwise path around the workpiece; left hand tool (LL): counter clockwise tool rotation – clockwise path around the workpiece).



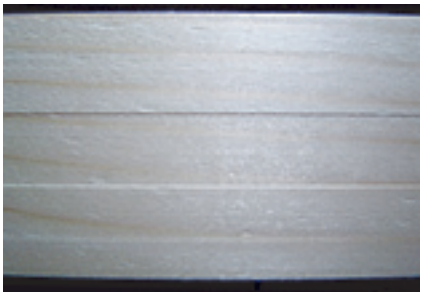
Leitz combination router with right hand and left hand cutting edges for reverse without a cutting tool change.

Cutting against the feed gives a high cut quality at the point where the tool enters the panel but has a risk of tear-outs or chipping the material where the tool exits the workpiece. Often the only way to avoid chipping the workpiece at exit is to use an additional tool rotating in the opposite direction to the first (left hand and right hand rotations). Typically this strategy requires a time-consuming tool change. Leitz offers a tooling solution eliminating the tool change on CNC machining centres. Saving a tool change time greatly increases the productivity of a costly CNC machine. The Leitz solution is a left hand and right hand rotation tool on the same shank. The bottom part of the tool is LL, the upper RL. Instead of an time-consuming tool change, the spindle rotation is simply reversed and the spindle height (Z-position) adjusted to use the required part of the tool’s cutting edge.

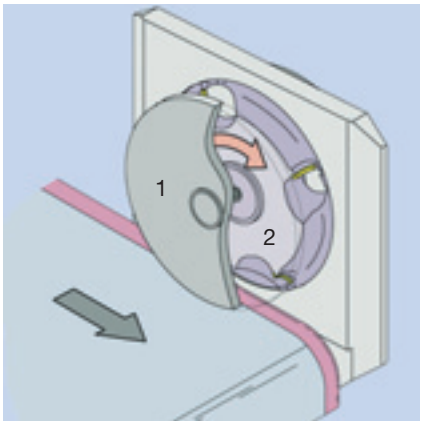


PKD or tungsten router cutters with up or down spiral cutting edges.

Many router cutters have a plunging tip for entering the panel’s surface vertically. It is not recommendable to use router cutters as one would use a drill. Router cutters are designed for routing – not drilling! The two correct procedures when using a router cutter to enter into a panel’s surface from above are:
1.) **ramping,** a simultaneous movement of the tool in Z- and XY-position. This is a diagonal path similar to an airplane landing
2.) **downward helix,** the tool path scribes a small circle at the same time as lowering the Z-position.
If a router cutter is used as a “drill”, the chips are not be properly expelled from the tool’s cutting edges. Incorrect use of the router cutter builds up heat, creates burn marks, causes premature wear to the tool’s cutting edge and can ultimately cause the tool to break.



Lines from tools with segmented cutting edges caused by runout.



Tracing device,
1 Tracing wheel
2 Tool.

Most shank tools for machining laminated panel materials have an alternate shear cutting edge design. The question is when to choose a tool with positive (up-shear) or negative (down-shear) cutting edge geometry. On CNC machines with high suction router cutters with positive shear angle improve the chip flow into the dust extraction as the up-shear carries the chips upwards. But using positive shear tooling requires strong vacuum clamping to hold the workpiece in position as the up-shear creates cutting forces that will try to pull the workpiece off the suction cups. To ensure a chip-free top surface when machining pre-laminated panel with predominately positive shear angle router cutters, the Z-position of the tool must be adjusted to each panel thickness. The cutting forces on router cutters with a negative shear angle support the material clamping forces, but inhibit the chip flow.

Machining edge banding materials on CNC machining centres is with special aggregates supplied by the machine manufacturer; the positioning of these tracing aggregates has to match the machine's control unit. Leitz supplies tooling and spare cutters for these cutterheads to the machine manufacturer's specifications.

When machining MDF and other homogeneous panel materials the best finish quality is with tools with full profile cutting edges (large tungsten carbide knives or diamond jumbo tablets). Tools with split cutting edges and alternating shear angles (the shape of a profile is made up of several overlapping cutting edges) causes the fibres of MDF or similar materials to be pressed in different directions depending on the shear angle of that part of the tool profile cutting edge. This effect can create shadow lines clearly visible after lacquering or membrane pressing. When using tools with overlapping cutting edges, even the slightest run-out tolerances will result in visible lines often making the workpiece a reject or resulting in additional rework (sanding). Run-out tolerances originate from numerous sources. The machine spindle, the clamping system (chuck and collets), the tool or simply vibrations (material or machine related) are the cause of run-out tolerances. Designing tools with full profile cutting edges has limits and requires compromises in both the direction and angle of shear.

Tool clamping systems have an important role in CNC machining. Precise clamping of CNC tooling is highly critical especially when using tools with staggered cutting edge geometries. The type of CNC machines tool interface can mean the difference between a high quality finished product or a reject. Leitz hydro clamping chucks offer a certain degree of self-damping ideal for heavy duty routing applications. But in terms of rigidity and precision the Leitz ThermoGrip shrink-fit chuck is the ultimate shank tool clamping system currently available. With a run-out tolerance of a few microns it can tackle most applications where lines from overlapping cutting edges are a problem.

Tracing aggregates or so-called "floating heads" are often used when machining feature grooves in MDF panels or solid wood on CNC machines. A number of other machining applications also require a precise referencing to the panel top surface (e.g. connecting grooves for kitchen worktops). Unless tracing aggregates are used, the thickness tolerances in the wood or wood based panel materials will result in varying groove depth, effecting the appearance of the profile. Floating heads eliminate these problems as they machining to a constant depth in relation to the top surface of the panel.

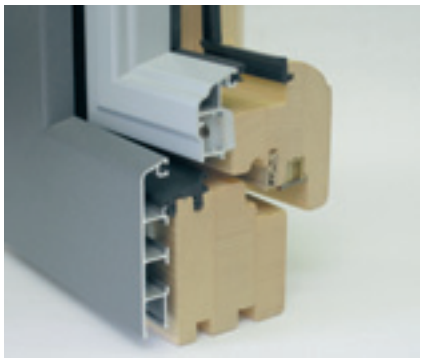
5.1 Window production

All aspects of product ranges associated with building and construction, the design and construction of external elements – windows and doors – and interiors – stairs, doors, flooring, panels and mouldings – is geared to the needs of the market and the expectations of the ultimate customer, your customer.

The emphasis in the past was mass production, but the trend today is for individuality. Customers are again taking a close personal interest when it comes to the design of their houses, both inside and out.

This trend has stimulated the development of new generations of machines and machine tools. For example window production is moving towards industrial large-scale production and volume manufacture; unfortunately this meant standard designs in terms of the window details both in Europe and around the world. But in the future, whilst the windows will have to meet performance standards they will have more individuality.

Similar patterns are also apparent when it comes to doors, stairs and flooring production. Windows, doors, stairs etc. are not only necessary practical elements in houses but also a feature of interior design. All parts in the construction are now becoming interior design elements.



Window production

Apart from wood and aluminium, steel, glass and plastic are used alongside wood when it is exposed to the weather. Today there are three basic types of window.

- Single-glazed window:
  a single window frame fitted with a single glass panel
- Insulated glazed window:
  a single window frame with two glass panels – either single or insulated – hinged to the window frame so the glass panels can be opened independently for cleaning.
- Double glazed window:
  Two frames with a space between them hinged to each other; the inner frame is fitted with an insulated glazed panel.

The industry today produces many designs of windows with some still made by small joinery companies. Apart from traditional wooden windows, compound structures are now produced combining the properties of various materials.

A wood/Aluminium window is now an established design as wood and Aluminium complement each other perfectly.

Aluminium with its resistance to the elements is ideal for the “weathered surfaces”, whilst the inside has the benefit of the warmth of natural wood.

Heat loss through windows is a topical subject today especially in low energy and passive energy houses. Energy loss is determined by the frame and glass. The solution is for parts of the window frame and sash to be made from compound materials with a thickness of 140 mm. Aluminium is used on the outside (weathered surface) and cork, PU foam, or Purenit etc. used to form the insulating layer.

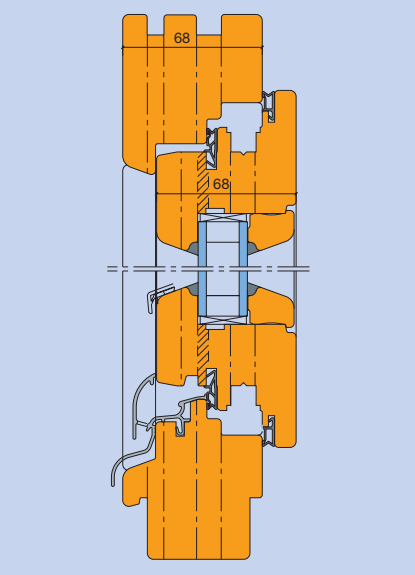
5.1 Window production

Leitz has been responsible for much of the development of these types of window resulting in the VariTherm L, VariTherm K and VariTherm H window designs.

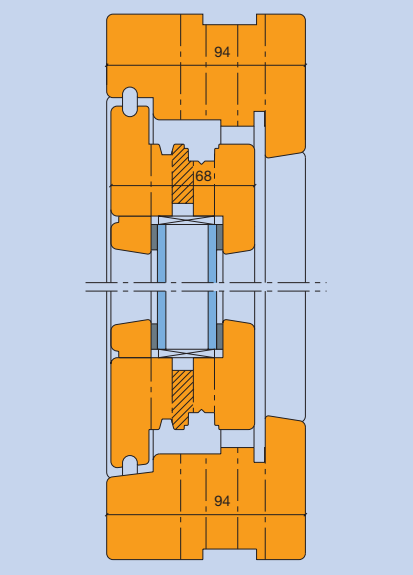
Specific window designs

Window designs are as different as the different countries. As a leader in this industry, Leitz has solutions for all the styles, designs, standards and production techniques used around the world.

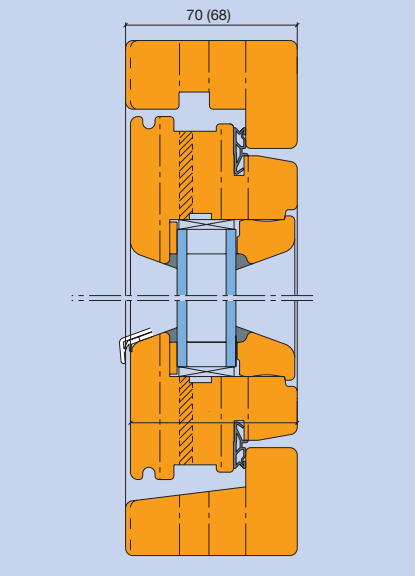
Single-glazed window – wood



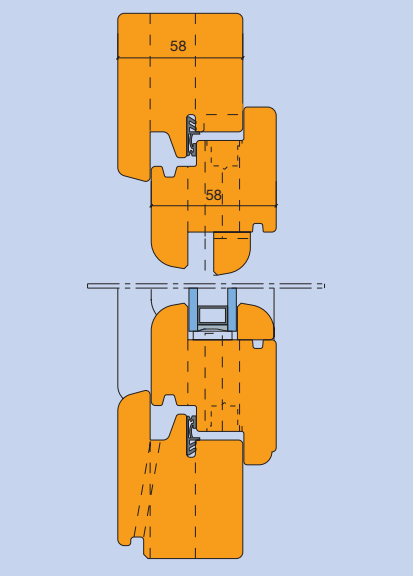
IV 68 – Typical for Germany



Open out without rain protection strips
Single rebate frame seal
Flush casement Typical for GB

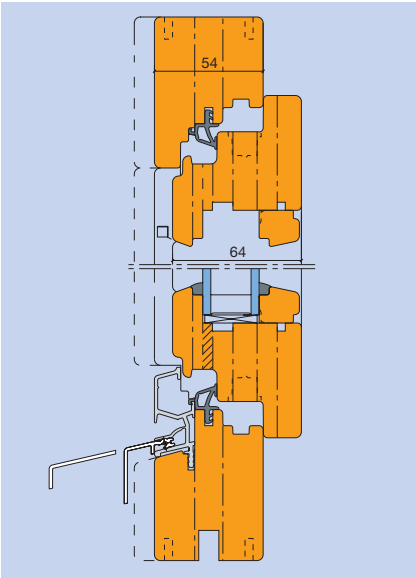


Open out without rain protection strips
Single rebate frame seal
Typical for DK and Baltic countries

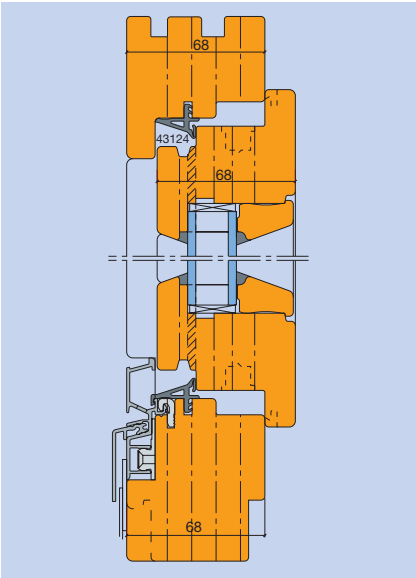


Open in without rain protection strips
Double rebate frame seal
Typical for Italy

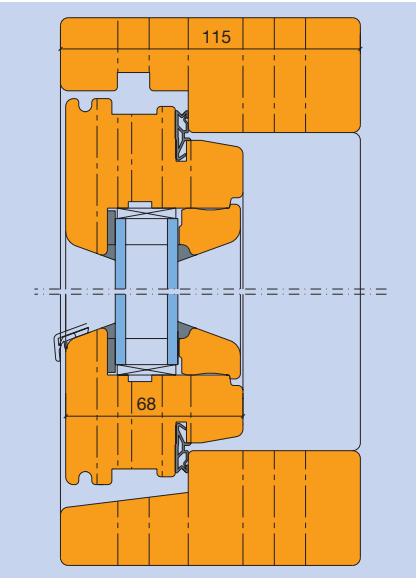
Single-glazed window – wood



Open in with rain protection strips
Double rebate frame seal
Typical for Switzerland

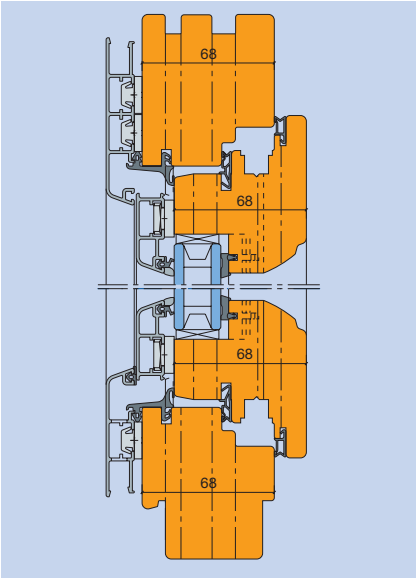


Open in with rain protection strips
Double rebate frame seal
Typical for Central Europe

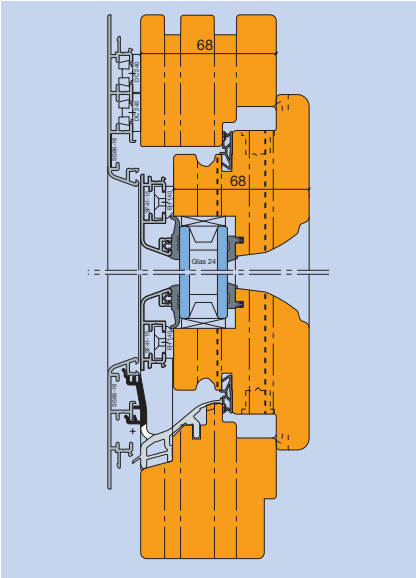


Open out without rain protection strips
Single rebate frame seal
Typical for Scandinavia

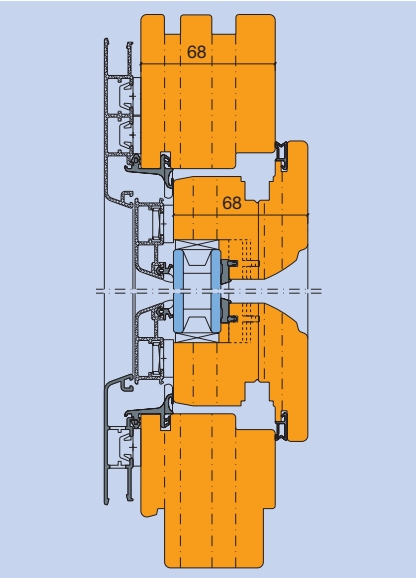
Single-glazed window – wood/aluminium



Open in double rebate
Wing seal and frame seal
Typical for Germany

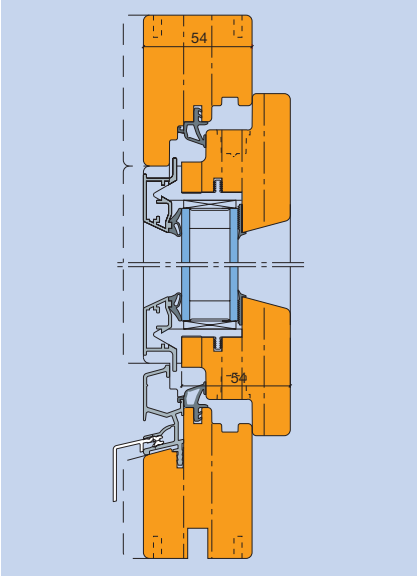


Open in double rebate
Wing seal
Typical for Central Europe

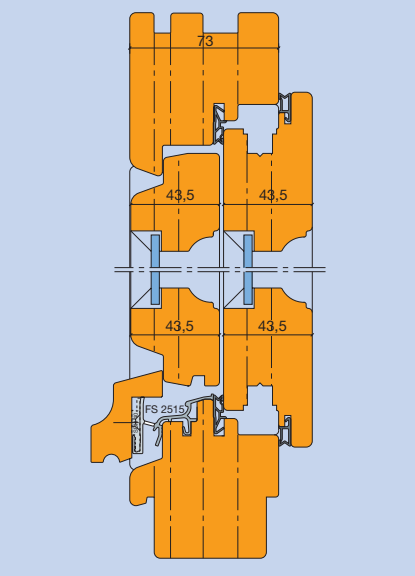


Open in double rebate
Frame seal
Typical for Central Europe

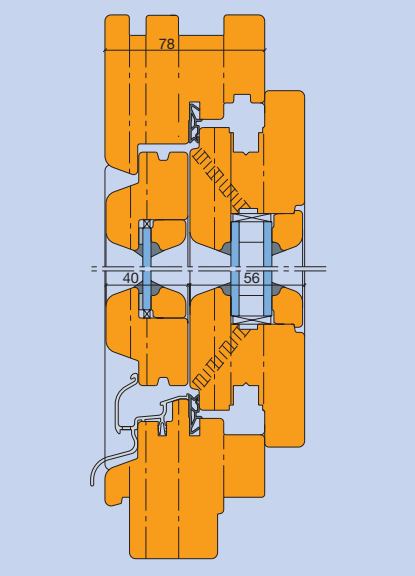
Compound window – wood



Open in double rebate
Frame seal
Typical for Switzerland

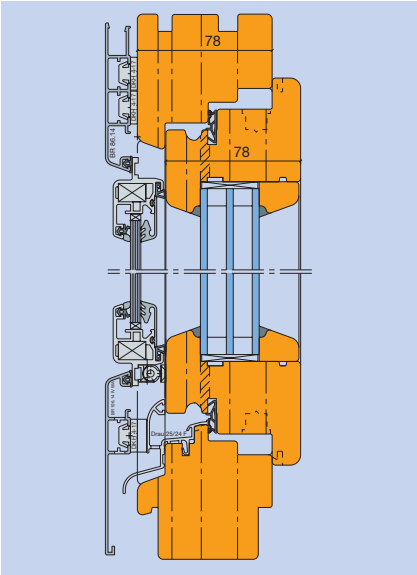


Open in with rain protection strips
Double rebate frame seal
Typical for Central Europe



Open in with rain protection strips
Double rebate frame seal
Typical for Central Europe

Compound window – wood/aluminium



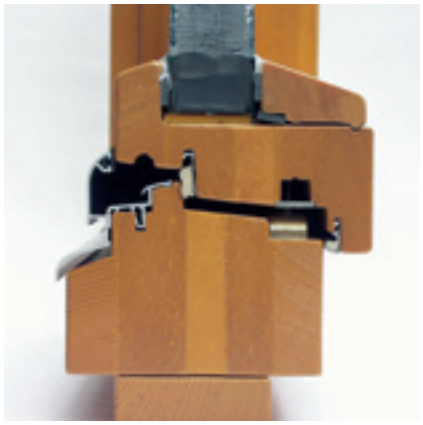
Open in with rain protection strips
Double rebate wing seal
Typical for Central Europe

5.1 Window production

Windows for passive and low energy houses
A passive energy house is a building in which a comfortable interior climate is created without a heating or air conditioning system. The house heats and cools literally in a passive manner.

Window designs suitable for passive energy houses have a higher glass quality and a thermally improved frame compound to meet a heat transition coefficient of Uw = < 0,8 W/(m²K).
The frame cross-sections are increased, traditional wood components are replaced by compounds and the heat transition coefficient for the glazing Ug = 0,7 W/(m²K) is taken as the basis for the calculation.

Leitz offers VariTherm L, VariTherm H and VariTherm K window designs, all have been tested and all are suitable designs for passive energy houses.

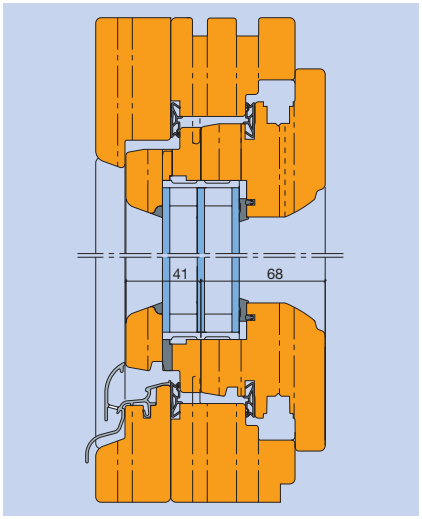


VariTherm L

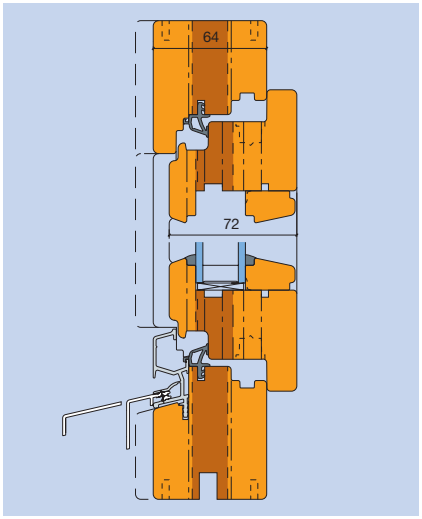
Low energy windows
The heat transition coefficient for these designs of window equals Ug = < 1,1 W (m²K).
Certification is not necessary for low energy house windows.

VariTherm H

VariTherm K



Example of low energy window
Solid wood frame



Example of low energy window
Compound frame
Swiss low energy window

To maintain the performance, the wood moisture content should be in the range of 11 % to 13 % from the start of machining through to delivery of the window.

5.1 Window production

Constructive wood protection means that any water must be directed to flow to the outside. Horizontal areas exposed to weathering should have a bevel angle of at least 15°. All outside edges should be have a radius of at least a 6 mm for an even application of finishes whilst the inside edges need a radius of at least a 2 mm for varnishes. The air circulation groove around the glazing unit must be ventilated at the top and bottom outside of the middle seal. Aluminium profile claddings are recommended on all the lower horizontal components exposed to extreme weathering. All these requirements have implications on the design of the tools.

Volume window production: when processing larger quantities of one part, parts with the same profile and similar lengths are combined as a group to be machined as a batch without any machine adjustments. Series production is best on double-sided machine as this reduces the production time.

Window production to order: when processing the frame and sash components parts to order, the components, are machined one after the other. All the components for a window are machined as a batch and remain together until the window is assembled. Single-sided machines or CNC machining centres are used for small, variable orders because of their flexibility.

Frame finishing: the outside frame profile is machined after the frame is assembled. This is one of the most popular methods in window production today.

Component production: the four faces of the timber, and if required the slot and tenon, holes and routing are machined to make an individual component. The window is then assembled from the components. As the components are completed prior to assembly, this eliminates the time required to machine the outside profile. Less space and fewer machines are required. The wood can be treated (impregnated) prior to assembly. Component part production is becoming more common.

Complete sets of tools or profile splitting: the full profile is machined in one step with a single tooling set. This is the most common production method from a spindle moulder to a window production line. The individual profile tools guarantee constant profiles. Profile changes or a different timber thickness may mean altering the tools.

Profile tool-splitting is ideal when producing a range of different products or profile. Profile splitting is becoming increasingly popular as it offers flexible production. By splitting we mean splitting the complex tooling sets into individual tools, and using the individual tools on several spindles.
The complete profile is built up of a number of processing steps giving profile flexibility without changing a tool. The individual spindles are numerically controlled to bring them into the correct position to make the complete profile. Tool-splitting gives profile flexibility, reduced machine downtime and minimises the number of tools.

5.1 Window production

ProFix-Cutterhead set mech. feed.

ProfilCut-Cutterhead set
for manual feed/mech. feed.

Turnblade knife Cutterhead set
for manual feed/mech. feed.

Exact slot and tenon set
mech. feed.

It is important to consider the machine technology. Profile flexibility can only be achieved with several vertical and horizontal spindles arranged in a sequence one after the other. Multiple passes across the same processing spindles can increase the profile flexibility, but throughput is reduced. For this reason planning the position of the tools on the right spindle is critical. When planning and selecting the tools it is necessary to differentiate between the profiles for volume production – those requiring the minimum throughput time – and the additional parts where flexibility is the prime importance. Without tool changes different designs of window can be produced efficiently with these machines and tooling concepts.

Leitz tooling systems
Window tooling systems have had an important influence in the development of window technology. Leitz tooling systems are designed to give the best performance, economic production flexibility, long tool life and ease of use.

Innovative window tooling systems: constant diameter/constant profile tools using ProFix, ProfilCut, exakt knives or turnblade knives.

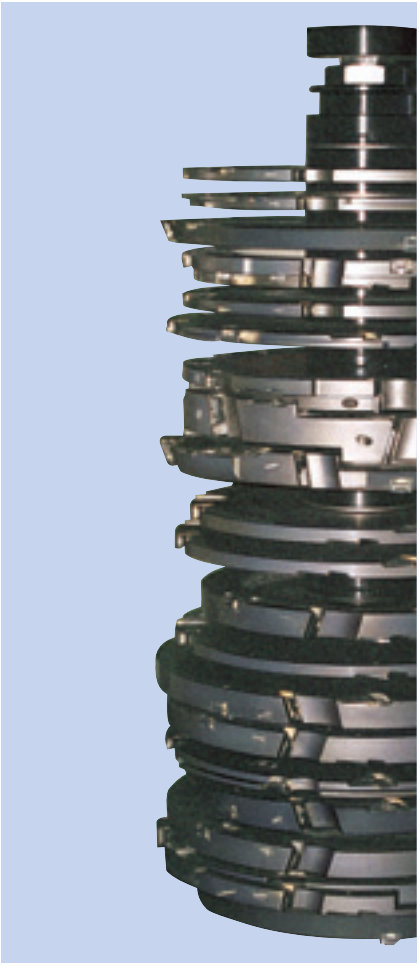
Machines
The speed of development of machines and machine technology makes it seem that traditional machines (hand fed machines) are slowly but surely becoming a thing of the past.

But not true. The machines and working procedures below show that, depending on the product volumes, window manufacture uses the whole machine spectrum – from a spindle moulder to a CNC machining centre.

Spindle moulders
The spindle moulder has kept up to date with many developments – adjustable spindles, inclined spindles, sliding tables, quick release tool clamping and digital/electronic setting and control systems.

5.1 Window production

Working step	Machine
Slot and Tenon profile	Spindle moulder with sliding table
Counter profiles	or single end tenoner
Internal profiles (inside profile + glass bead)	Spindle moulder
Assembly	Frame clamp
Profiling	Profile grinding machine
Outside profile (frame and sash)	Spindle moulder
Hinge recesses	Drill/router
Fitting glass bead	Mitre saw



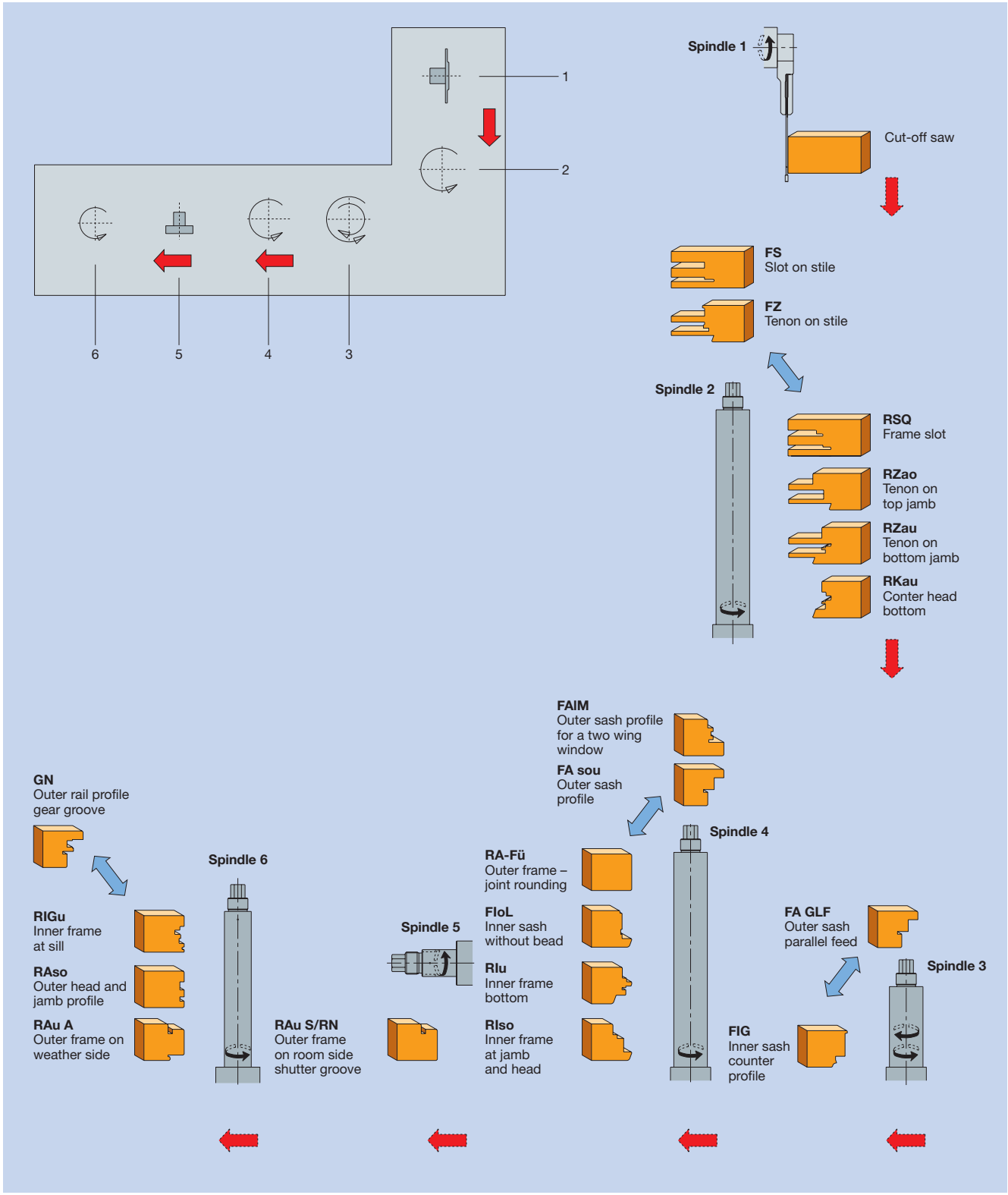
Window tooling on stacked spindle.

Machines for window production
The basic design of window making machines allows for either batch or to-order with continuous manufacture without stopping or work in progress. The frame and sash components are first planed on four sides, cut to size and then end profiled for the slot or tenon. Next the components pass the profiling spindles automatically for length profiling.

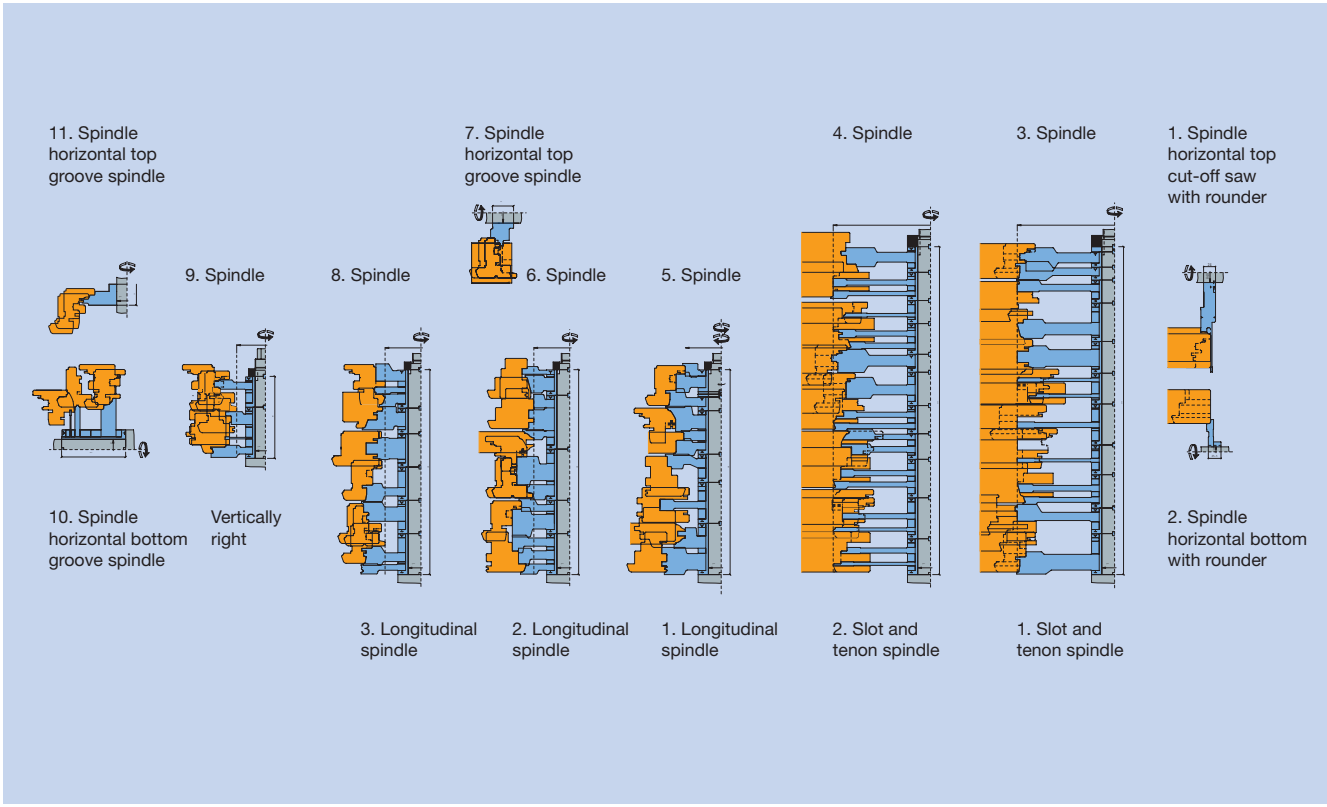
Most basic window making machines process the components on an order basis first machining the inside profile and the slot and tenon for assembly in the window clamp. After assembly the frames are returned to the machine so the outside profile can be added.

The machine feed system ensures there are no breaks in production. The sets of tools are mounted on stacked spindles, and the NC control brings the spindle into the correct position. Depending on the number and length of the stacked spindles, the tooling on the machine may have to be changed from the frame tooling to the sash tooling and vice versa.

Working procedure	Machine
Slot and tenon	Window production machine
Length profiles	Window production machine (incl. RA profile)
Assembly	Frame clamp
Profiling	Profile grinding machine
Outside profile	Window production machine (incl. Parallel feed)
Hinge recesses	Drill/router
Fitting glass bead machine	Mitre-/Double mitre sawing



The steps in mailing wooden windows are arranged across a number of spindles. Several spindles, one after the other, eliminate machine adjustment and save time. Machines of this size are designed for tool-splitting with many tools mounted on the spindles. Alternatively tool magazines can be used with an automatic tool change.



Example of profile splitting

Efficient use of window making machines requires either full sets of tools or tool-splitting. Leitz offers tooling systems designed to suite the different types of machining system in terms of spindles, configuration and production cycle.

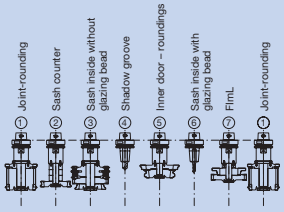
Linked machines

Window manufacturing companies making larger volumes can link the individual machines together with handling equipment to form machine lines. In a linked line the workpieces remain at the same height from the start of the process through to assembly etc. The design and configuration of linked lines offer many options. However the design of a linked production line needs careful consideration at each processing step, in particular the processing time at each step, to ensure a constant flow through the line without stops. Any delay is detrimental to the linked line principle. Specifying tools for a production line demands a detailed list of all the processing steps, the sequence and task. Like a symphony, it must work in harmony.

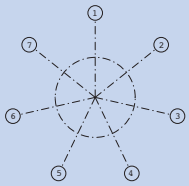
CNC-processing centres

CNC machining centres are single muli-function machines equipped to meet the user's specific requirements. CNC machining centres are popular with smaller companies as they are flexible, suit varied production, and precise. Simply, all designs of Leitz tools are suitable for CNC machines. The different tooling systems are made to suit the machine processing steps. The Leitz range of CNC clamping systems guarantees quick and easy tool change, optimum tool performance and a high finish quality.

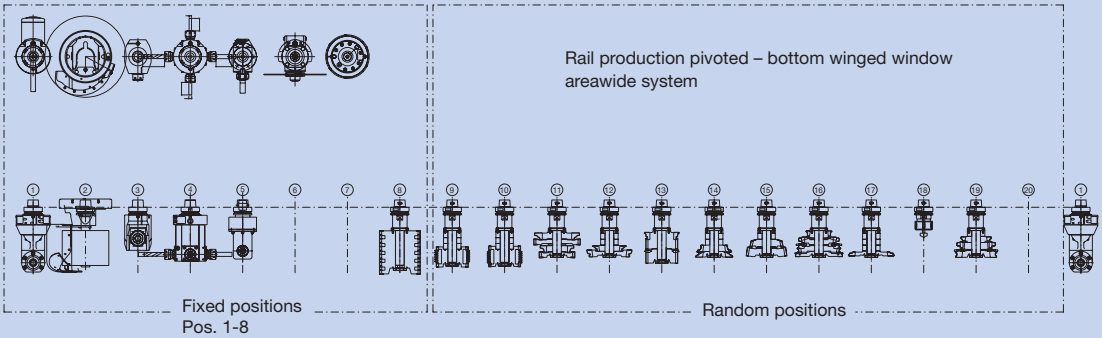
Fix assignment
on seven position
revolver magazine:



Seven position –
revolver magazine
(view from top)

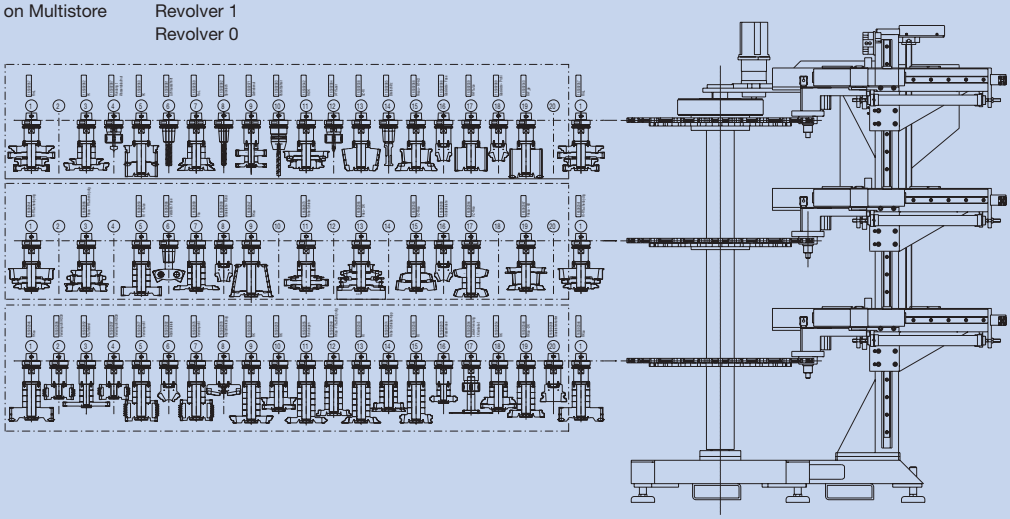


Assignment on
20 positions chain:

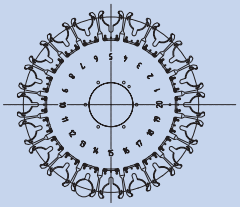


Assignment
on Multistore

Revolver 2
Revolver 1
Revolver 0

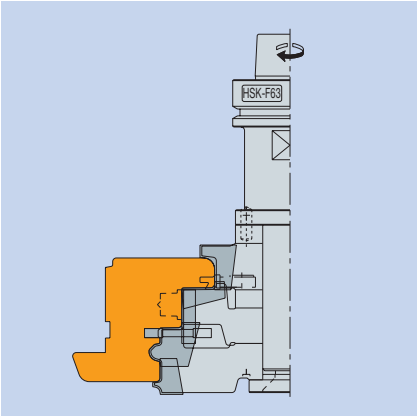


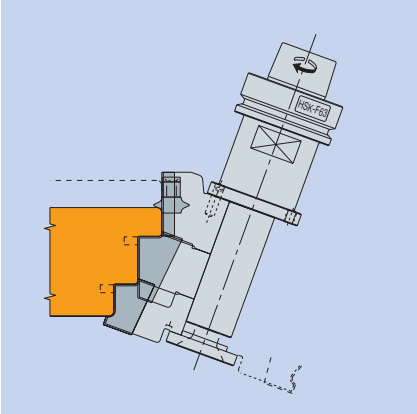
3x20 position –
revolver magazine
(view from top)



Tool set of CNC-machining centre.

5.1 Window production





CNC technology with inclined spindle.

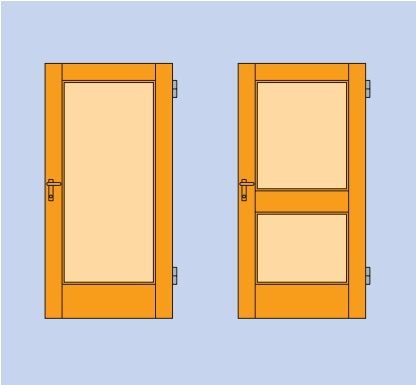
Aluminium bodied Leitz tools have more advantages. The reduced tool weight keeps the weight within the limit set by the machine manufacturer. Also Aluminium means the machine runs quieter, and the reduced tool weight extends the life of the machine spindle bearings.

Profile tools for shallow profiles are best machined with a tool with a small maximum diameter. This benefits the finish quality as there is little variation in the cutting speed – the variation in diameter is small because of the lower profile depth. Also the maximum tool r.p.m. and feed speed are higher because of the smaller diameters, and the cutter wear and the cutting forces evenly distributed.

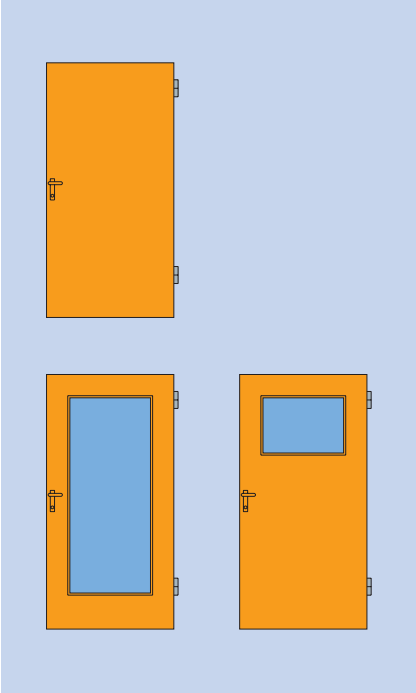
The flexibility of CNC machining centres opens new ways to make existing products as well as for manufacturing new products. When it comes to producing wooden windows, changes in the accessories or design – new hinges, different glass rebates for new glass thicknesses, a new design of window bars or even combination windows, passive house window systems etc. – imply changes to the tools and the machining processes. Whilst previously companies may have had to invest in machines, tools and new processes, machines centres can be adapted to the changes quickly.

5-axis technology is a development of 3-axis technology (basic machine) – the 4-axis can be achieved on 3-axis machines with aggregates. 5-axis technology can be used to incline the head so rebates are machined with a bevel cut. The average depth of cut has the benefit of greater chip clearance. Inclining the head also has positive benefits on power, cutting pressure and the entry and exit angles. Also by rotating the tool in the 5-axis, the cutting angle can be optimised for the workpiece material. So 5-axis technology has significant benefits in production.

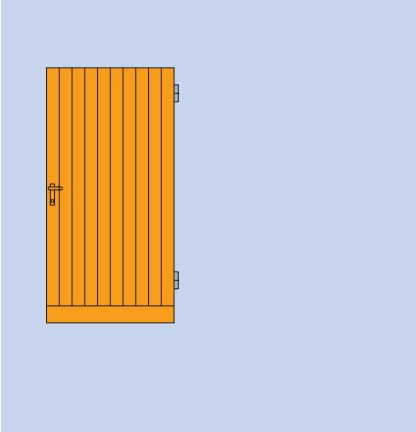
5.2 Production of external house doors



Framed door.



Plywood doors without and with glass vision panel.



Tongue and groove panel door.

In Germany, and also in the neighbouring European countries, production of external doors for houses has not changed to volume production to the same extent as wooden window production. The reason is simple, external doors are a statement to people approaching the house. Builders and house owners alike are still prepared to invest money in specially designed external doors.

There are three basic types of construction:

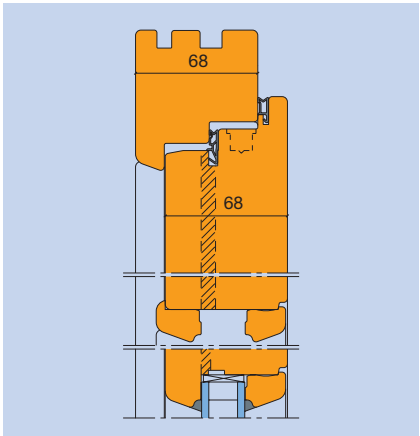
Framed and panelled doors comprise of vertical and horizontal components which are either joined with dowels or a slot and tenon or mortise joint. The frame may have none, one or more wood or glass panels.

Plywood doors/board doors basically comprises of plywood panels assembled symmetrically. Plywood is used as the outer skin as the different orientations in the plywood layers minimise the risk of twisting. A plywood door comprises of two plywood panels of the same thickness and a solid wood frame around the edge of the door. Plywood doors with/without a glass vision panel: Depending on the insulation and security aspects additional pieces may be added to strengthen the door.
In Germany plywood doors are manufactured to the national standard DIN 68706. The design in other countries is specific to that country and depends on the EN performance standards.

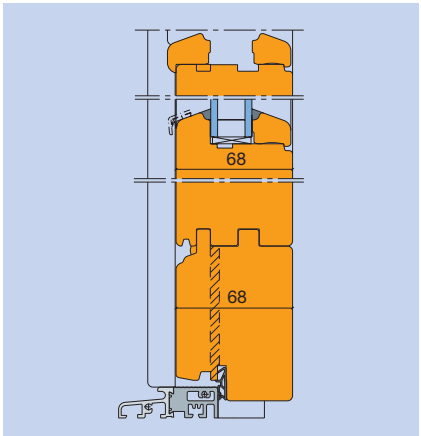
Tongue & Groove Doors: depending on the design these may or may not have a frame and have tongue & groove cladding on one or both sides.

In future, as a part of European standardisation, only the requirements and specifications will be set as standards, not the design or construction.
In Germany, as in other countries, the external house door profiles, as far as possible, match those of the wooden window so can be machined with the same tools. There are also other constructions that are not, however, binding from a technical standpoint.

External house door
Machines used for window production are suitable for external house doors. Profile moulders are essential for house door manufacture. In large companies making large volumes, moulders are used to process individual and

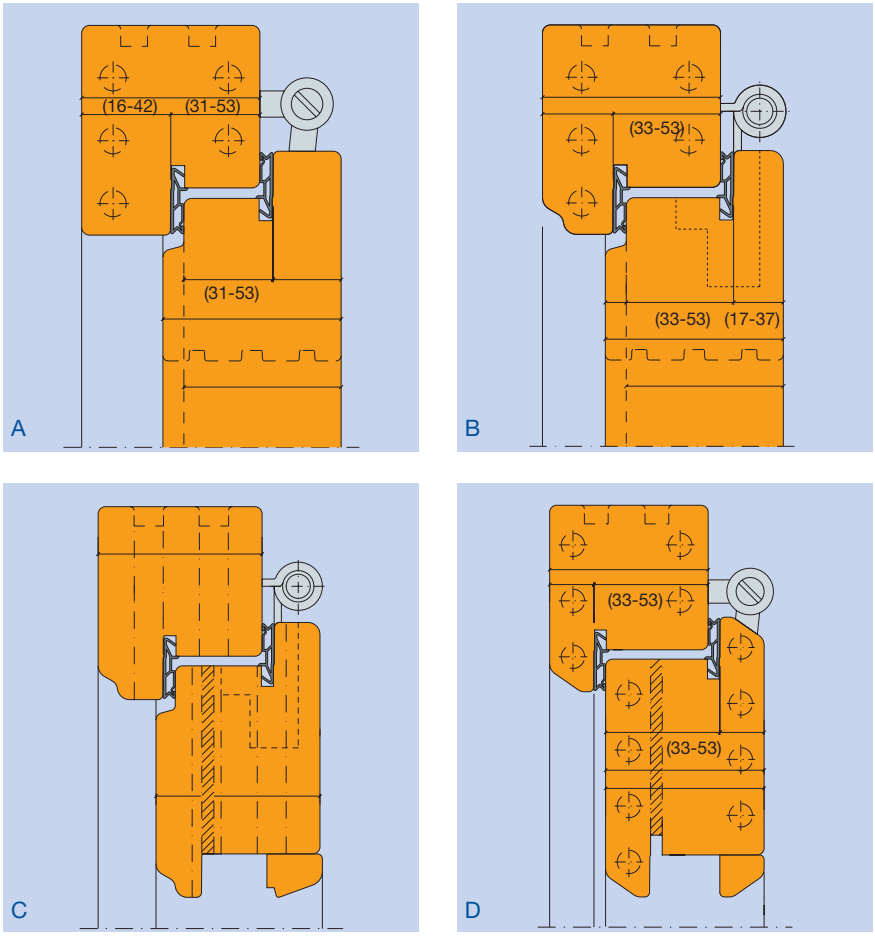


IV68 wood – rebate air 4 mm – double rebate open in top … bottom



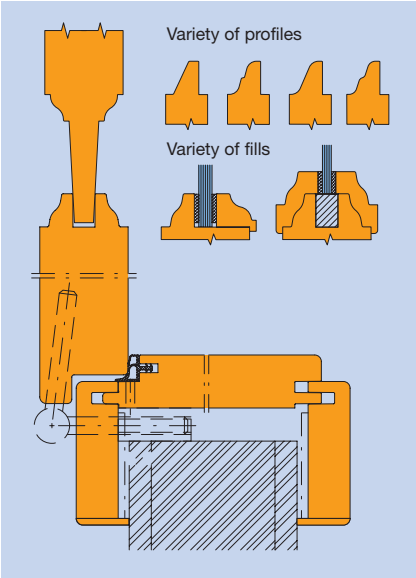
special components. Leitz has developed an interesting and unique solution for making doors on spindle moulders – four different door designs produced with the same tool. The Leitz designed single set of tools manufactures the doorframe internal profile, doorframe internal counter profile, and the door external profile with minimal adjustment as the tools are zero set and have a constant null diameter.

Profile variants

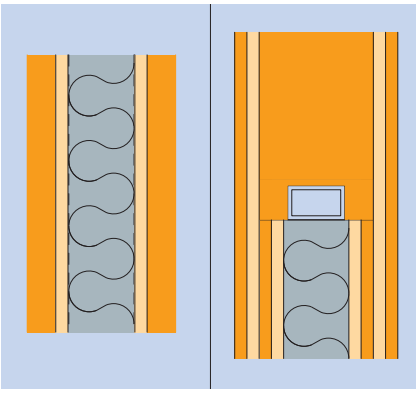


When a company also manufactures wooden windows, using the window making machines to make doors is logical as it helps rationalise production. From a technical and constructional point the profiles of the wooden windows and external doors can be designed to meet the technical requirements of security, insulation etc. Essentially external construction parts are very similar in specification. The window production tools (possibly with a few additional tools) can be used for external doors with few if any modifications. As with window production, the process starts with cutting to length and then end profiling the slot and tenons. If the frame – rails and stiles – are joined with dowels, it is not necessary to slot and tenon the components, only to counter profile. A dowel-drilling device can be added to the window machine if justified by the production volumes. For small companies, or small levels of production, it is more economical to dowel on a separate machine. If tools need to be changed frequently, a quick release chuck will reduce down time. The increased use of **CNC machining centres** in small companies means even small companies can manufacture different designs and dimensions competitively and quickly to the required quality. The Leitz tool programme offers all the tools need by these machines.

5.3 Internal doors



Basic diagram of a framed internal door.



Basic diagram of a flush panel internal door.

E.g. assembly:
7 mm solid wood
3 mm plywood
Alum. insert
16 mm hard foam
Alum. insert
3 mm plywood
7 mm solid wood

The term “internal door” means doors not exposed to the outside atmosphere. Internal doors are used to connect and separate rooms. They are designed to seal, insulate and protect (fire protection, security from burglars) plus trouble-free day-to-day operation.

Internal door manufacturers have the task of matching the ascetic qualities with the functional properties when producing framed or flush panel internal doors.

Spindle moulders, with tools specifically designed for the application, profile and the material of the internal doors – offer a high product quality and quick adjustment. Leitz profile cutterheads machine the rebated door frame lining and facing/architraves to accept the design of door.

The same tool is used to machine both the length and cross profile door edge profiles on the spindle moulder. Up to five different profile variants – radius edges, chamfer etc. – can be produced with the same tool body by using exchangeable knives.

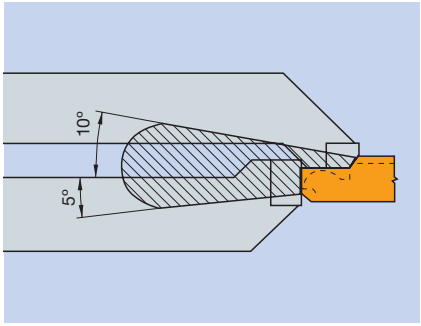
CNC machining centres can be used not only for specific processing steps on internal doors, door, door frames etc. but also for a wide range of special features. The door frame lining, both length and cross profile, can also be profiled and jointed on the machining centre. Using exchangeable knives one tool can machine a wide range of different profiles

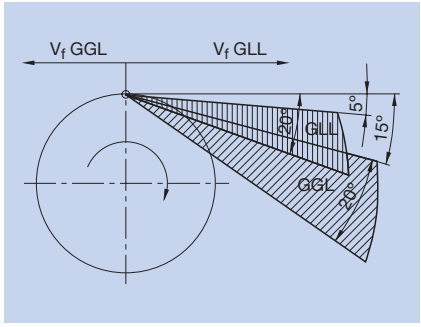
5.4 Flooring production

There are many elements in interior design, but flooring is central. It is the flooring we see first when we enter a room.

Parquet flooring is a special design of flooring, and because of the different designs and manufacturing processes can be divided into the two categories – multi-layer and solid parquet.

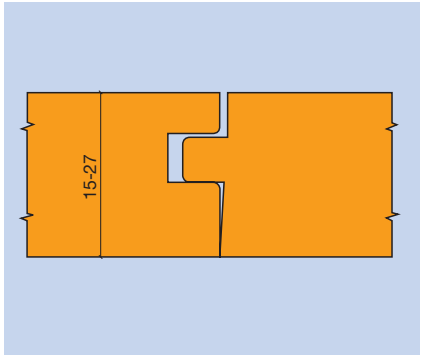
The tooling technology for parquet and laminated flooring production considers not only the tool geometry and cutting materials, but also collecting the dust and chips. Tools and tool sets use the dust flow control (DFC) design concept. DFC technology directs the chips away from the machined workpiece and the tool cutting edge. This increases the tool life by eliminating double cutting of the chips and improves the product quality by preventing the chips from marking the workpiece surface and damaging the cut edges. DFC extends the life of the machine parts, lowers machine maintenance costs, and increases productivity by reducing the non-productive time spent cleaning and maintaining the machine. So higher machine utilisation, and stable production. Leitz uses its knowledge of the chip flow to optimise the design of the machine dust collection and extraction hoods.



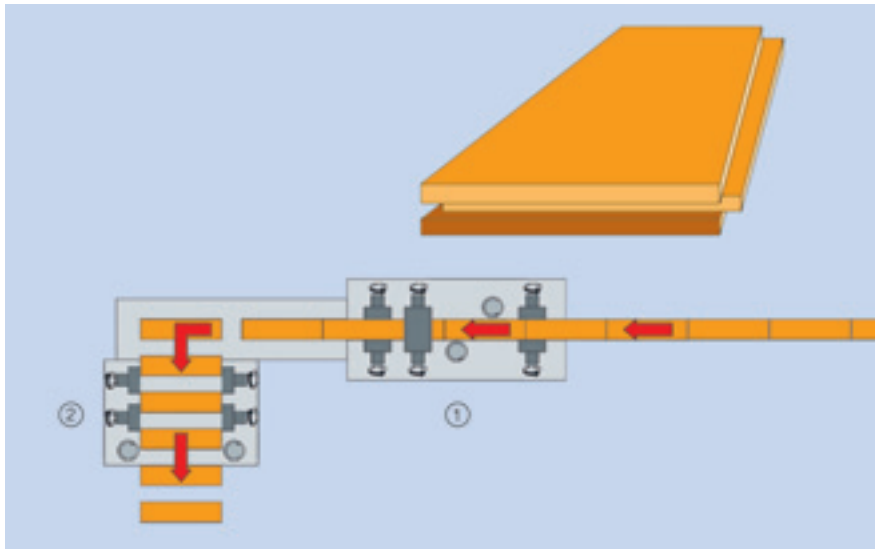


Chip flow diagram for Leitz-tools when machining flooring panels.

Solid parquet flooring



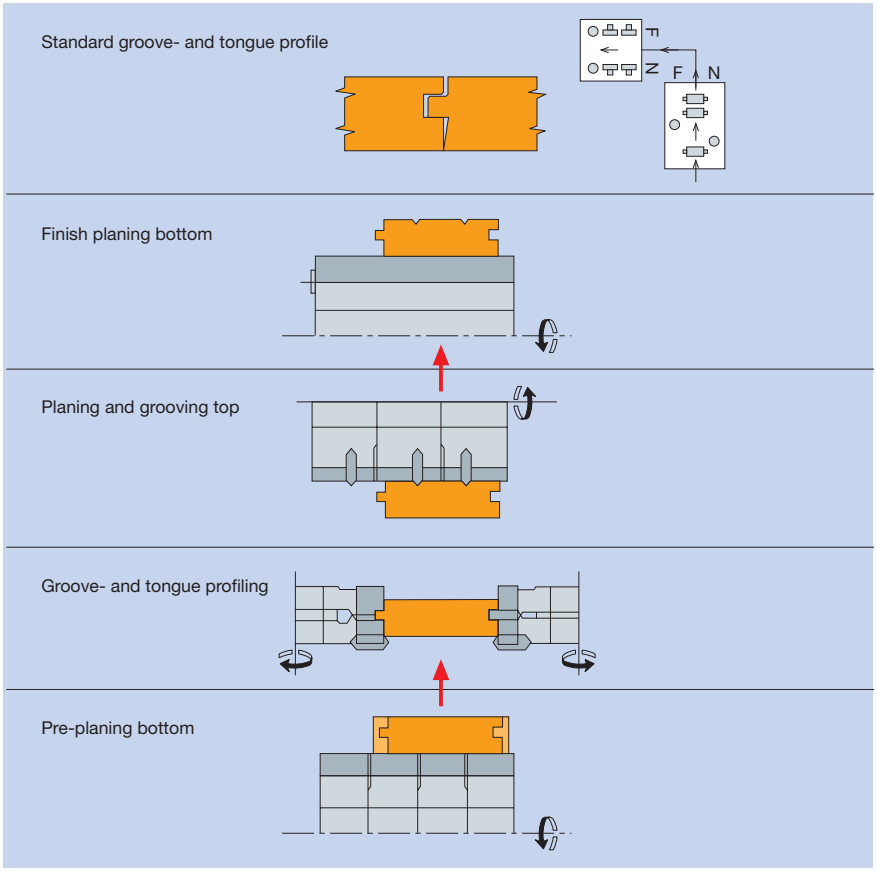
Solid parquet flooring 15-27 mm standard tongue and groove profile along and across the panel.



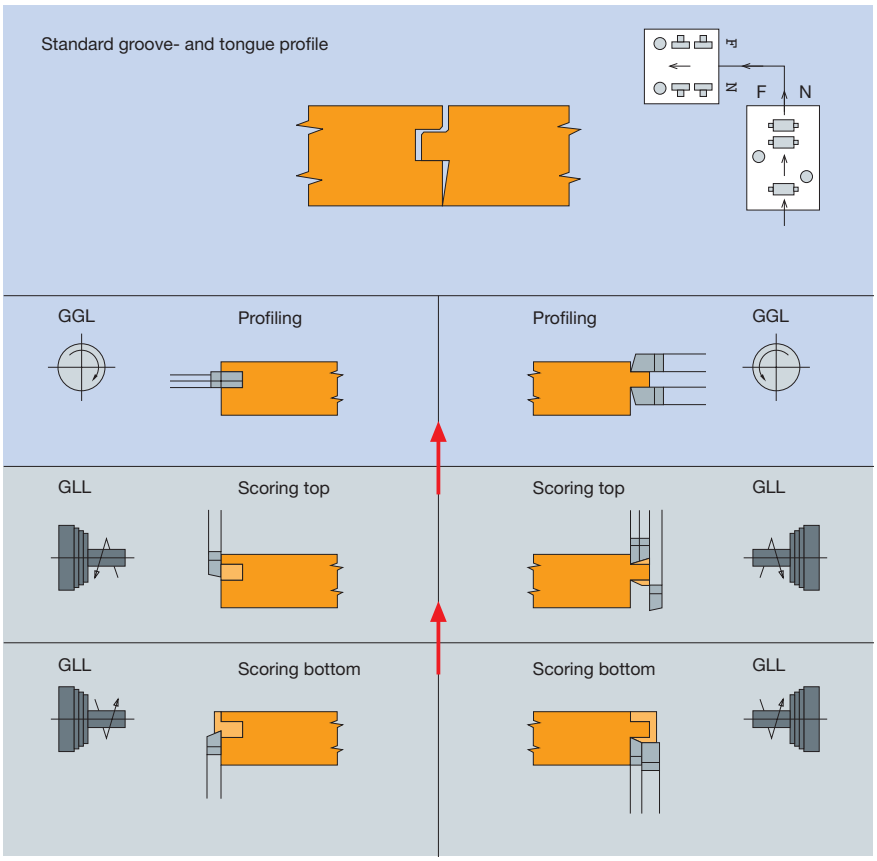
Layout of a multi-layer parquet flooring production line.

Solid wood parquet blanks are machined on two machines usually linked at 90’ to each other. The first machine, a four-side moulder, machines along the grain, the second, a double end tenoner, machines across grain. The machine line layout is as the above illustration.

5.4 Flooring production

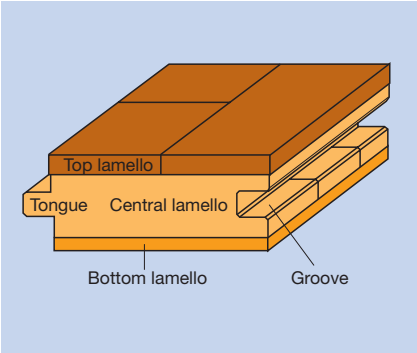


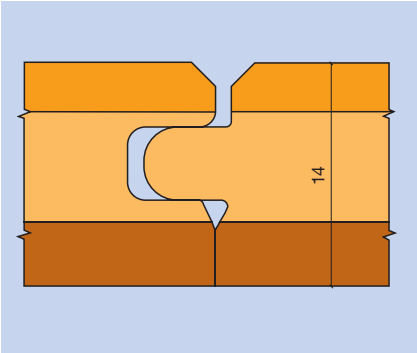
Machining along the grain machine 1: Profiling along the grain on a 5-spindle four-side moulder.



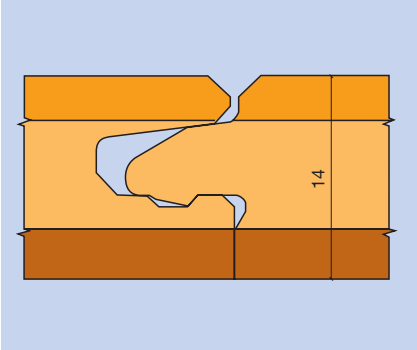
Machining across the grain machine 2: Profiling across grain on a 3-spindle double-end tenoner.

5.4 Flooring production





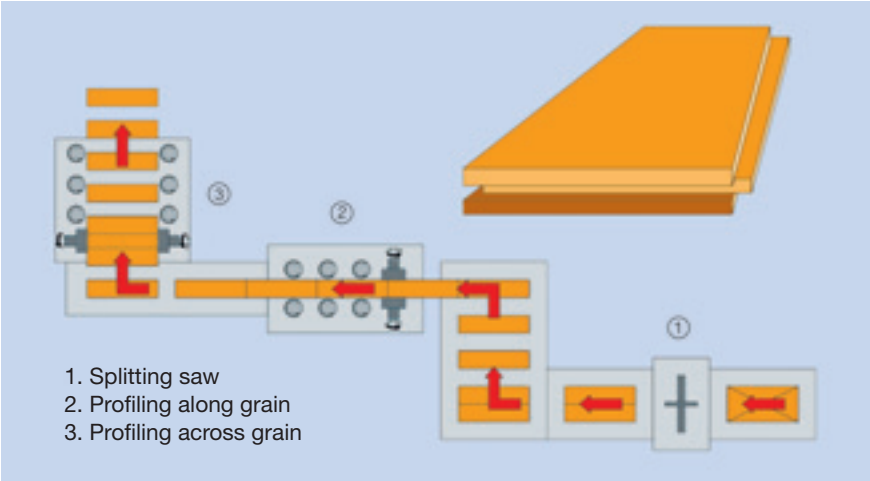
Standard tongue- and groove profile
3-layer parquet 14-15 mm



Click-profile
3-layer parquet 14-15 mm

Mulit-layer parquet (solid wood)

Theses can be split into two types – standard tongue and groove profiles and the click profiles for glue-free assembly. A typical production line with a cross cut saw and length and cross profiling is shown below.



Basic scheme of a multiple-layer parquet production line.

Lamello production – thin kerf

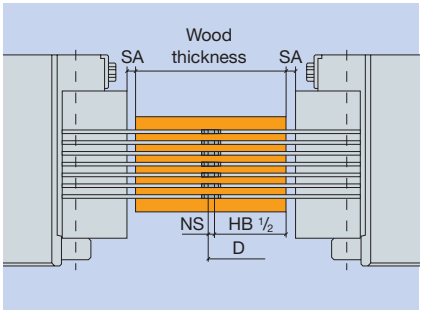
Thin kerf and very thin kerf circular sawblades – words, which promise much but have both economic and ecologic benefits. Like all high-tech products it is important that the thin kerf saws are used correctly. With a cutting width of as little as 1.2 mm Leitz thin kerf technology sawblades reduce the material lost in the cutting operation, give high cut quality, accurate sawn strips and a high performance.

Applications for thin kerf circular sawblades span from cutting high volumes on high-speed production lines to producing thin strips of expensive exotic timber.

Cutting widths of 1.2 mm-2.5 mm are possible.

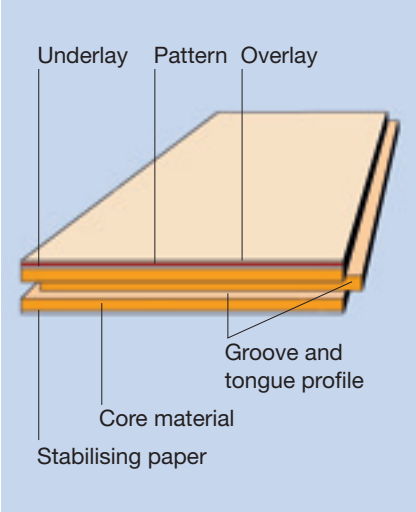
Horizontal lamello production

The cutting width can be between 1.2 mm-1.4 mm with a fine cut quality up to 40 m/min.



5.4 Flooring production

Laminate flooring is very popular. The hardwearing surface and the wide choice of designs expands its use and allows for designs to suit personal tastes. Leitz tooling systems machine wear-resistant laminated flooring in 3-shift operation to a high quality with minimum tool down time.



Assembly of a laminated panel.

Material

Laminate flooring is a ready-to-lay floor panel with a tongue and groove profile and a very hardwearing surface layer. The core materials of MDF, HDF or chipboard are either coated with decorative papers impregnated with a melamine resin or laminated with a high-pressure laminate (HPL). The panel pattern is protected from damage – mechanical or thermal – by a transparent overlay. The high scratch and wear resistance properties of the overlay come from the aluminium-oxide granules in the overlay.

Similar wear protection layers are used on veneered parquet flooring. Aluminium-oxide particles are added to the varnish and applied to the surface of the wood.

The laminate overlay layer is the main wear factor. The thin 0.1 mm overlay of small aluminium-oxide granules is very abrasive to the tool cutting edge. Wear to the tool cutting edge from the core material is negligible in comparison.

Profile

Glue-free laying systems are established in the market. Standard tongue and groove profiled panels are rare and only produced in small quantities.

Click profiles are patented in almost every country and manufactured under license. Because of the patent laws in each country, the exact position should be established before manufacturing a click profile or taking a licensing agreement with a patent owner.

As a rule, at least 4 or 5 machine processing steps are needed to produce a click profile. The process and processing steps depend on the profile and need careful analysis.

Chip removal

Today's machine lines operate at feed speeds up to 200 m/min in two and three shift operation, and the greatest percentage of the profiles are click profiles.

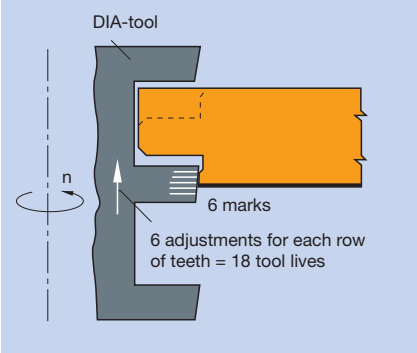
The machine wear is very high from the constant stream of dust of aluminium-oxide particles in the overlay. This means higher costs plus unproductive machine downtime for maintenance.

DFC tool with a 30° working angle.

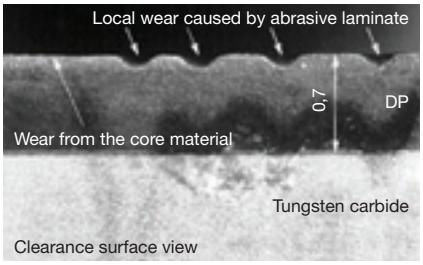
The machine part life of the wear parts can be increased by more than 100 % by using Leitz's new dust flow control (DFC) tool technology with suitable extraction hoods. The new tool designs with DFC geometry direct the chips into the mouth of the extraction hood.

The DFC principle acts as a fan within the tool. The tool complements the extraction system lowering the required suction power. The combination of the DFC tool design and the Leitz designed extraction hood means that nearly 100 % of the dust and chips are collected.

Another benefit is, for high machine feed speeds, the number of teeth required can be reduced by up to 50 % with DFC technology lowering the tooling costs and reducing the motor power.



Special tool for tongue side finish jointing cutter.



Wear to a PKD cutter after machining the laminate surface:
Wear grooves, caused by the abrasive overlay (tool adjusted 4 times).
Wear to either side of the overlay groove from the core material.

Tools
The tool life criteria are set by the quality of the machined laminate edge, i.e. chipping to the coating layer. This can only be achieved with sharp cutting edges of mono-crystalline diamond (MKD), chemical vapour diamond (CVD) or polycrystalline diamond (PKD).

Machining the laminate edge on the panel tongue side is the most difficult processing step in terms of tool life and tool use. The efficiency of the tooling system is set by this position – Leitz has designed a special tool for this operation. As the range of adjustment is restricted by the tongue, the tool has three separate rows of teeth used one after the other giving 6 adjustments for each row of teeth. So with three rows of teeth the tool has 18 tool lives. If two of these special tools are mounted as a set one above the other, then there are 36 adjustments between tool changes.

The illustration to the left shows the wear to a PKD cutting edge from the overlay after several adjustments. The part of the cutting edge machining the overlay layer is evident by a distinct groove. Experience is that this design of tool can run for several shifts without a tool change and give a high edge quality.

MKD tools
The mono-crystalline diamond (MKD) is harder and more wear resistant than polycrystalline diamond. Today tools with MKD cutting edges are used on high-speed lines because of their long tool lives. Compared to PKD tipped tools, MKD tools have 10 times the run time. CVD tool performance is between that of MKD and PKD. Flooring manufacturers should consider the advantage of using MKD tools on their own lines, but there are other points to consider.

1. MKD tools are much more expensive than PKD or CVD tools and can only be resharpened on special grinding machines. Resharpening is not available in all countries.

2. MKD cutters are not available in all sizes. The most common sizes have cutting widths of 3 mm and a resharpening life of 2.5 mm. Larger MKD tips are available in limited quantities but the price increases dramatically with the size of the tip.

5.4 Flooring production

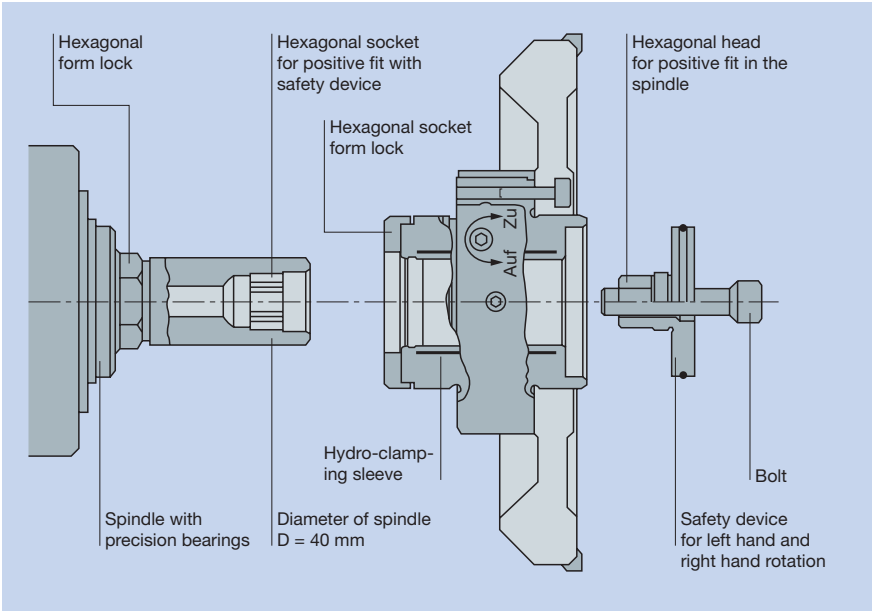
MKD cutterhead

CVD tools
A CVD is a diamond material without a binding agent (see the chapter on cutting materials). Compared to MKD, CVD cutters are available in all sizes. CVD cutters can be eroded and so either eroded or resharpened on conventional diamond grinding machines.

Mounting sleeves
MKD; CVD and PKD diamond cutting edges are very sensitive to impact damage. Good tool balance is essential to minimise vibration and the risk of cutting edge damage. Apart from the balance quality, a high run-out tolerance accuracy is important for all the tool cutting edges to machine the material to give a smooth surface. Leitz, with the machine and motor manufacturers, developed a new design of sleeve especially for these processing lines to give a high product quality, for ease of use and high tool safety – the Leitz Hydro-Format-System, known as the HF-System.

Tools mounted on these tolerance-free self-centring hydro sleeves, on high-precision motor spindles and sharpened with the latest technology have a run out tolerance of less than 0.02 mm. High balancing qualities of G 2.5 can be repeated time and time again.

The result is in the economics; the tool cutting edges divide the work evenly and so wear evenly. This results in a high machined quality and long tool life. The high balance quality gives the tools vibration-free running. This translates into greater reliability as the wear to the tool cutting edges, in particular PCD, is from abrasion from the material not premature damage from impact.


Hexagonal form lock
Hexagonal socket for positive fit with safety device
Hexagonal head for positive fit in the spindle
Hexagonal socket form lock
Auf
Zu
Hydro-clamping sleeve
Bolt
Spindle with precision bearings
Diameter of spindle D = 40 mm
Safety device for left hand and right hand rotation

Leitz HF-system – the standard mounting sleeve for sizing.

5.4 Flooring production

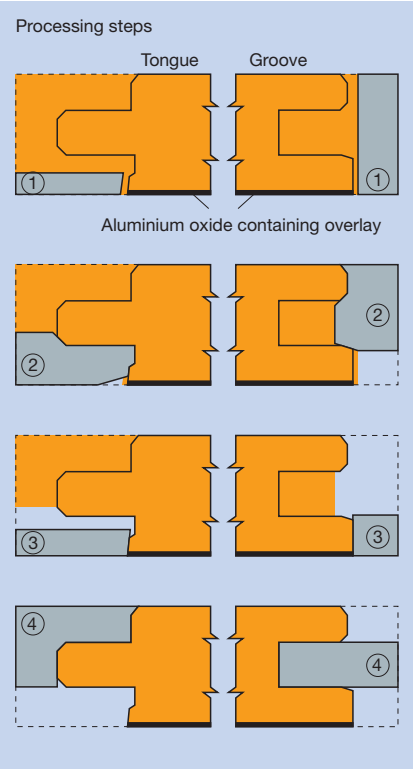
Machining on continuous machine lines
The materials and material composition determine the machine processing steps. Leitz has considered these and developed processes to maximise quality and minimise costs.

The most important criteria are:
– Splitting the profile into a series of processing steps
– Selecting the correct tools and tool mounting interfaces
– In-house support and tool maintenance.

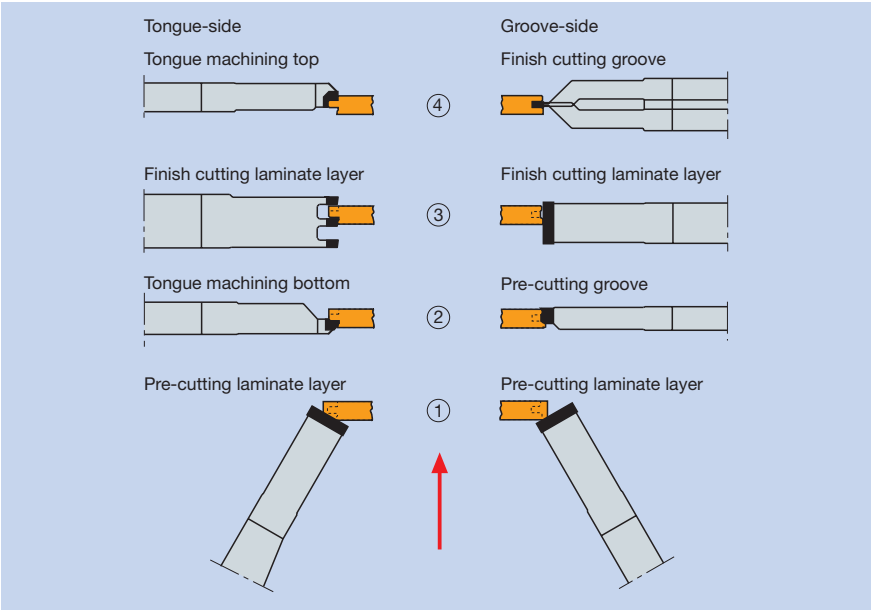
High tool availability is guaranteed by using the same tools on the machine line for cutting along and across the panel so the tools can be exchanged between the first and second pass machines. This eliminates tool bottle necks and reduces the tool stock.

In the process the profile is split into separate steps so the diamond tool performance is optimised for the different layers in the laminate.
On continuous lines it is important to reduce the set up or adjustment times, for example the tools for the tongue and groove joint. The economics are in minimising the processing costs by increasing the machine efficiency by reducing the downtimes arising from the tools.

Profitability:
– Lower unit costs per square metre
– Short investment pay-back period
– Increased competitiveness from higher product quality and lower production costs
– Higher productivity by reducing the machine downtimes.



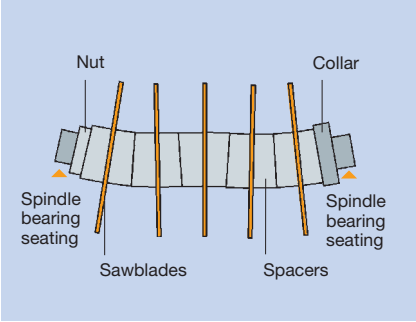
① Pre-cutting laminate layer
② Pre-cutting groove/tongue
③ Finish cut laminate layer
④ Finish cut groove/tongue



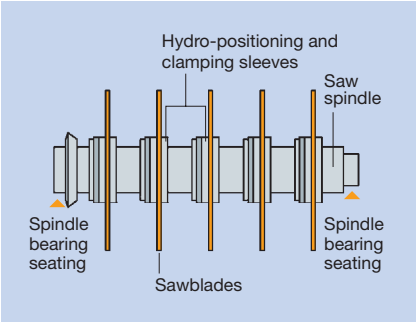
Leitz laminate flooring panel production technology on a 4 spindle machine.

5.5 Panel and moulding production

Wall and ceiling panels are made in a variety of designs and usually covered with either foil or veneer. The core material is either chipboard or MDF.
The panel profiles can have a shallow tongue and groove, a deep tongue and groove or an interlocking profile. The profiles can have either square-edges or eased edges. High quantity demands these panels are made on high feed speed machines. Today, feed speeds up to 300 m/min are possible.



Spacers: The saw spindle is distorted by the tolerance in the sawblades and spacers or dust.



Hydro clamping: the sawblades are positionend and clamped independently. The saw spindle is not distorted.

Sawblade mounted on hydro sleeve.

Chipboard or MDF as the core material
Chipboard or MDF is usually used as the panel core material. A very small number of high-quality panels are made with a solid wood core.

The largest proportion is made from MDF and subsequently either painted or wrapped with foil or veneer.

However more and more chipboard is being used as the core material because of price. But the cheaper the core material, the more difficult the machining process. This is the problem when processing chipboard.
The loose middle layer creates high demands on the cutting process for products with long tongues. Leitz has developed concepts for high feed speed machining of chipboard to an high quality.

The raw material is split on multi-rip saws with one-piece spindles. Splitting the panels into strips is either with tungsten carbide or DP-tipped sawblades. The distance between the sawblades depends on the width of the strip and adjusted with spacers. To minimise the tool change time when changing to different widths, the spindles with pre-set sawblades are ready and changed when required. Inaccuracies arise from this conventional method of positioning and clamping the sawblades with spacers because of the compound tolerance of the spacers. This results in the spindle distorting giving the sawblades a poor run out tolerance reducing the tool life. Vibrations arise from the sawblade bore machine spindle tolerance creating an unbalance.

The solution is to hydro clamp the saws and hoggers. The hydro clamping sleeves allows the sawblades and hoggers to be positioned and adjusted to any position along the spindle.
The lightweight clamping sleeve, which slides easily along spindle and over joints of composite spindles, has an integrated aluminium locking collar.

The distance between the sawblades and the hoggers is changed and adjusted without gauges or spacers. In minutes a complete spindle assembly of sawblades and hoggers can be mounted, adjusted and clamped in place.

5.5 Panel and moulding production

To change the material width the hydro sleeve clamps are released and the tools moved to their new positions. By eliminating the sawblade bore – machine spindle tolerance and the spacers, the machine spindle no longer distorts. The result – a quiet machine with fewer spindle bearing failures, an excellent cut and up to 50 % increase in tool life. The latest design of narrow hydro sleeves makes minimum widths of 50 mm possible. Full details of the clamping sleeves can be found in the Lexicon chapter “sawing”.

Profiling
Panels are profiled in a number of steps and machined on the long and short sides with different machining concepts.

Hydro clamped diamond tools are used when profiling at high feed speeds. Profiling can be on double end tenoners with accurate chains or airbeds, or on high speed moulders with precise spindles; spindle speeds are between 6,000-8,000 r.p.m. and feed speeds up to 300 m/min.

At profiling any subsequent wrapping process has to be considered – if the wrapping is a part of the process or if the profiled panels are held in a buffer store prior to wrapping on another machine. With through-feed wrapping the feed speed of the profiling machine is governed by the feed speed of the wrapping machine. When wrapping, the visible side of the panel has to be uppermost, so when profiling this surface must be on the top, so the panel does not need to be turned.

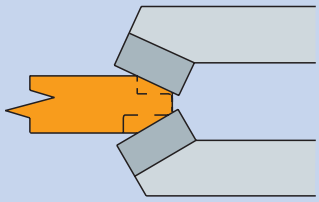
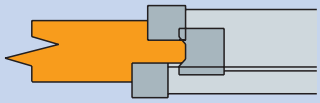
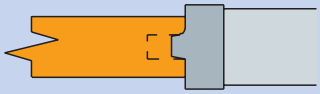
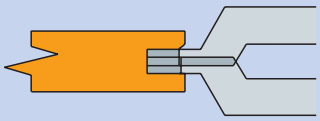
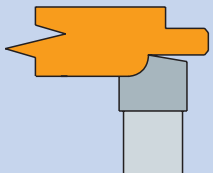
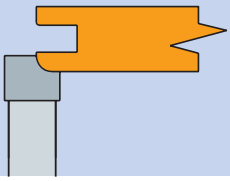
Once wrapped the panels are profiled on the short side, again on a double end tenoner. The tongue and groove profiles are critical when profiling the short side, especially on products with a deep groove. The problem area is, where the groove meets the tongue.

Profile tooling set.

Tools
Only diamond tools are used for profiling and there are some important points to consider. The diamond tips have to be positioned on the tool body so the overlapping cutting edges coincide with a edge or line in the profile. Overlapping cutting edges creates lines on the profile surface, which show through the foil after wrapping. The maximum possible cutting width of a diamond segment is restricted by how diamond is produced. The maximum cutting width of a profile from a single diamond segment is 50 to 60 mm.

Leitz has developed ways of manufacturing accurate diamond tools for high feed speeds, tools for feed speeds up to 300 m/min giving an excellent surface quality. The diamond tools are mounted on closed system hydro sleeves, eroded to profile and finely balanced. The tools must stay mounted on the hydro sleeve for the life of the tool and must be resharpened mounted on the pressurised hydro sleeve.

Production of wall and ceiling panels

Pre-cutting tongue 	Diamond cutterset, two-part, mounted on adjustable Hydro-Duo clamping sleeve.	V_f max 150 m/min Z 12/12 V_f max 200 m/min Z 16/16 V_f max 300 m/min Z 20/20
Tongue profiling 	Diamond cutterset, two-part, mounted on adjustable Hydro-Duo clamping sleeve.	V_f max 150 m/min Z 12/24 V_f max 200 m/min Z 18/36 V_f max 300 m/min Z 24/48
Groove pre-cutting 	Diamond profile cutter, mounted on Hydro-Duo clamping sleeve.	V_f max 150 m/min Z 12 V_f max 200 m/min Z 18 V_f max 300 m/min Z 24
Grooving 	Diamond groove cutterset, two-part, mounted on adjustable Hydro-Duo clamping sleeve.	V_f max 150 m/min Z 14/14 V_f max 200 m/min Z 16/16 V_f max 300 m/min Z 20/20
Profiling: Rounding on the tongue-side 	Diamond profile cutter, mounted on Hydro-Duo clamping sleeve.	V_f max 150 m/min Z 18 V_f max 200 m/min Z 24 V_f max 300 m/min Z 36
Profiling: Rounding on the groove-side 	Diamond profile cutter, mounted on Hydro-Duo clamping sleeve.	V_f max 150 m/min Z 18 V_f max 200 m/min Z 24 V_f max 300 m/min Z 36

5.5 Panel and moulding production

TurboHawk minifinger cutterhead.

Moulding production

Profiled mouldings are a volume product and can be produced either to order or as standard products in high quantities on high-speed machines. The profiles differ from country to country. The biggest demand for profiled mouldings is associated with flooring, wall and ceiling panels. A study has shown that every square metre of flooring or wall panelling needs 1 metre of mouldings. In 2003 the world production of laminated flooring was around 625 million square metres, and increasing. This means a demand for mouldings for this sector alone of over 625 million metres.

Jointed timber.

Solid wood strips

High-quality profiled mouldings are machined from finger jointed solid wood and are supplied either as untreated timber, veneered, wrapped or painted. Defects – holes, knots etc. – are cut out on high-speed crosscuts prior to finger jointing. For high volumes, finger jointing into lengths is on continuous machines with a capacity of between 120-180 parts/minute. Leitz has developed the TurboHawk finger joint cutterhead for quality finger joints at high feed speeds for these machines.

Horizontal splitting of solid timber.

To save timber, the raw timber is usually sawn into pre-shaped blanks after splitting and finger jointing. This doubles the productivity of the finger jointing machine and minimises wood waste. The sawblade cutting width (kerf) is small, between 1.8-2.4 mm, depending on the cutting depth and feed speed.

Solid wood mouldings are profiled on high-speed moulders with feed speeds of between 80-120 m/min. The quality requirement is high as any cutter marks or surface defects become visible when the surface is painted to the detriment of the end product. These faults are not as visible on unpainted mouldings.

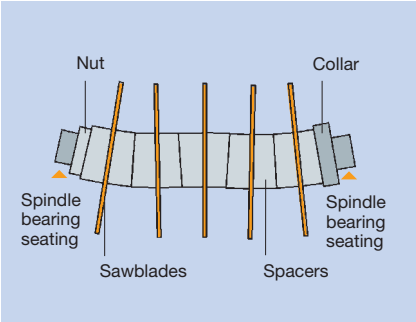
Profiling solid wood is usually with hydro profile cutterheads with serrated back knives profiled in the cutterhead. Marathon coated serrated back knives are recommended for an excellent surface finish and a high performance. The number of knives depends on the feed speed but as a rule 1 cutting edge is needed for each 10 metres/minute of feed speed. This means the tool has 8 cutting edges for a feed speed of 80 m/min and a spindle speed of 6,000 r.p.m.

Timber split into long lengths.

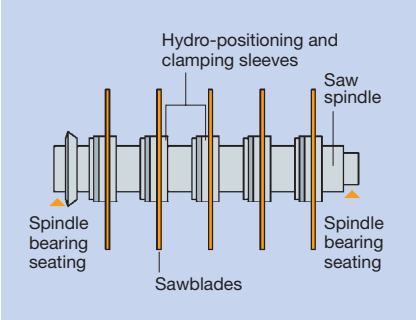
MDF wrapped mouldings

A large quantity of profile mouldings today are made from MDF and afterwards either painted or wrapped with foil or veneer.

The MDF panels are split into strips on multi-rip saws with one-piece spindles. Splitting the panels into strips is either with tungsten carbide or DP-tipped sawblades. The distance between the sawblades depends on



Spacers: The saw spindle is distorted by the tolerance in the sawblades and spacers or dust.



Hydro clamping: the saws can be positionend and clamped independently of each other. The saw spindle is not distorted.

Saw mounted on hydro sleeve.

the width of the strip and adjusted with spacers. To minimise the tool change time when changing to different widths, the spindles with pre-set sawblades are ready and changed when required. Inaccuracies arise from this conventional method of positioning and clamping the sawblades with spacers because of the compound tolerance of the spacers. This results in the spindle distorting giving the sawblades a poor run out tolerance reducing the tool life. Vibrations arise from the sawblade bore machine spindle tolerance creating an unbalance.

The solution is to hydro clamp the saws and hoggers. The hydro clamping sleeves allows the sawblades and hoggers to be positioned and adjusted to any position along the spindle.
The lightweight clamping sleeve, which slides easily along spindle and over joints of composite spindles, has an integrated aluminium locking collar.

The distance between the sawblades and the hoggers is changed and adjusted without gauges or spacers. In minutes a complete spindle with sawblades and hoggers can be assembled, adjusted and the tools clamped in place.

To change the strip width the hydro sleeve clamps are released and the tools moved to their new positions. By eliminating the sawblade bore – machine spindle tolerance and the spacers, the machine spindle no longer distorts. The result – a quiet machine with fewer and spindle bearing failures, an excellent cut and up to 50 % increase in tool life. The latest design of narrow hydro sleeves means minimum widths of 50 mm are possible.
Full details of the clamping sleeves can be found in the Lexicon chapter “sawing”.

Profiling
The panels are profiled in a number of steps and profiled with different machining concepts.

Small tool diameters running at a high r.p.m. (12,000) are becoming more and more accepted when making small quantities or to order. Z2 tools are used for feed speeds of up to 25 m/min, and the profiled surface finish is set by one knife. Jointed Z4 tools running at 10,000 r.p.m. are used for higher feed speeds, up to v(f) = 60 m/min. Leitz has special monoblock profile cutterheads with integral HSK mounting for these machines. The cutterheads use micro-serrated tungsten carbide blanks and backing plates profiled in the cutterhead. Tools with cutting widths of up to 320 mm and blanks and profile depths of up to 30 mm are available. The tungsten carbide blanks can be jointed in the cutterhead on the machine spindle to eliminate cutter marks on the profiles.

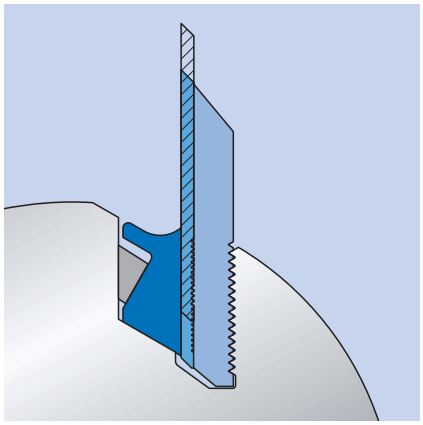
Hydro clamped cutterheads or diamond tools are used to profile high volumes of MDF. Profiling is on high-speed-moulders with accurate

spindles running at between 6,000-8,000 r.p.m and feed speeds of between 35-80 m/min.

At profiling any subsequent wrapping process has to be considered – if the wrapping is a part of the process or if the profiled panels are held in a buffer store prior to wrapping on another machine. With through-feed wrapping the feed speed of the profiling machine is governed by the feed speed of the wrapping machine.

The profiles can be made either as single pieces or multiples. If machined as multiples it is important to check that the mouldings all face the same way otherwise every second moulding will have to be turned longitudinally.

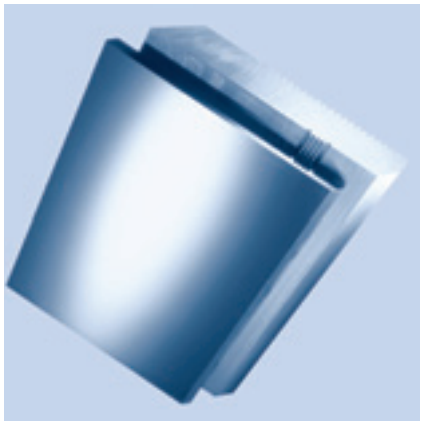
Leitz has a special micro-serrated tungsten carbide blank system for MDF moulding. One advantage is the moulding company can react quickly to customer requirements by profiling the blanks in-house. This system, compared to brazed-on tungsten carbide tipped blanks, has significantly reduced grinding wheel use when profiling the blanks. With brazed-on tipped blanks the steel backing and tungsten carbide cutting edge are profiled together. This results in high diamond grinding wheel wear, the wheel needs to be dressed frequently and the grinding wheel wears out quickly. The tungsten carbide cutting edge is profiled separately with the micro-serrated knife system extending the life of the grinding wheel dramatically. The micro-serrated knives can be jointed on the machine for higher feed speeds up to 80 m/min. The tool performance is independent of the feed speed.



Scheme: micro-serrated blank ans backing plate.

There are some important points to consider when using diamond tools. The diamond tips should be positioned on the tool body so that the overlapping cutting edges coincide with a edge or line in the profile. Overlapping cutting edges creates lines on the profile surface, which show through the foil after wrapping.

The maximum possible cutting width of a diamond segment is restricted by how diamond is produced. The maximum cutting width of a profile from a single diamond segment is 50 to 60 mm. The cutting width is reduced to about 30 mm on tools with high shear angles.



Serrated profile blank.

The feed speed is limited as the profile is always a one-knife finish as diamond cannot be jointed. The possible feed speed depends on the machine spindle speed.

rpm	6000 U/min	9000 U/min	10000 U/min	12000 U/min
Feed speeds	12 m/min	18 m/min	20 m/min	24 m/min

Leitz has developed ways of manufacturing accurate diamond tools for high feed speeds, tools for feed speeds up to 80 m/min giving an excellent surface quality. The diamond tools are mounted on closed system hydro sleeves, eroded to profile and finely balanced.

The tools must stay mounted on the hydro sleeve for the life of the tool and must be resharpened mounted on the pressurised hydro sleeve.

6. Machining on hand feed machines

On many woodworking machines the workpiece is moved by hand past the tool. They can – as an alternative to the hand feed – be equipped with mechanical feeding devices, known as power feed, but these machines still count as hand feed machines. As a rule you should only work against the feed on hand feed machines.

Traditional wood working machines such as spindle moulders or panel saws have been developed over the years with fences to guide the workpiece and adjustment devices that allow precise cuts and mouldings on straight or curved workpieces. Because of their flexibility these machines are used for special production in both small and large factories.

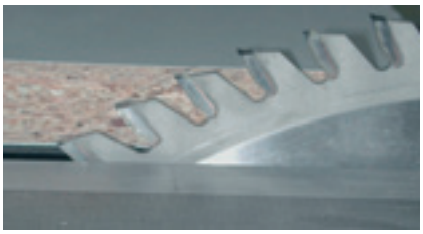
Statistics show that accidents on woodworking machines – especially on hand feed machines – are the most frequency and result in serious injuries. So, it is important, when using woodworking machine tools that the tools used meet the safety and technical requirements, and are approved for the task and machine in question.

For safe operation, the woodworking machine manufacturers user's manuals should be consulted, as they give detailed information on the safe use of tools, e.g. permissible speed ranges, mounting of tools, adjustments and settings, maintenance and repairs.

Leitz tools meet the Europe safety standards in terms of the technical requirements for shaping and planing tools, circular sawblades and clamping systems (EN 847).

6.1 Sawing machines

Clean precise cuts are required when sizing. Sawblades with a high number of teeth are advantageous, but when cutting solid timber across the grain and especially along the grain the cutting and feed forces increase significantly with a higher number of teeth. The greater effort required by the operator can cause inexact cuts or to low a feed speed making the sawblade "burn". Tungsten carbide tipped sawblades with alternate top bevel tooth shape can be used on table saws for most applications. Sawblades with flat/trapezoidal teeth are better for coated boards with hard or brittle coatings and abrasive materials. For hard, brittle and delicate materials sawblades with alternate top bevel teeth with bevel are recommended. Hollow/trapezoidal teeth saw blades are suitable for cutting coated boards on table saws without a scoring saw as they give a relatively good cut quality on the side the saw teeth exit from the workpiece. When cutting abrasive materials without a scoring saw, sawblades with flat/trapezoidal teeth and a negative cutting angle should be used. The negative cutting angle ensures the cutting forces work against the feeding force causing less tear outs to the cut edge

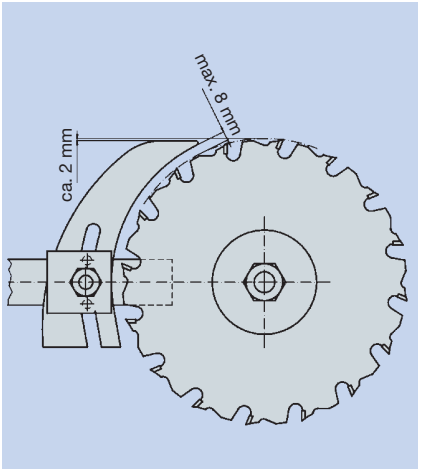


Exit angle with pos. cutting angle.

Exit angle with neg. cutting angle.

Standard sawblade projection.

Sawblade projection too large.



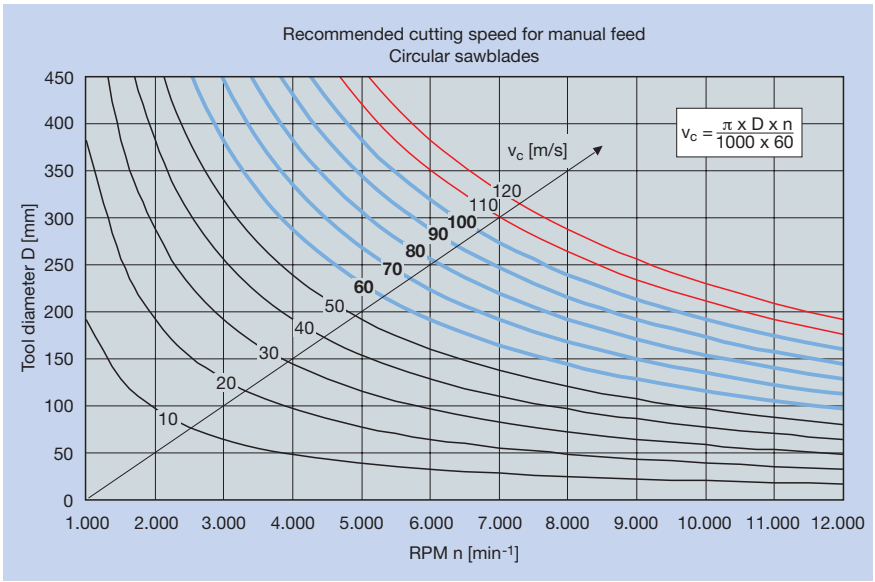
Adjustment of riving knife.

at the exit side, but higher feed forces are required. When cutting Aluminium and plastic extruded materials these sawblades are the only choice to prevent burrs to the cut edges.

The sawblade projection above the workpiece should be between 10 and 20 mm. All the recommendations in the Lexicon on tooth progression (tooth feed) values are based on these measurements. Larger saw blade projections reduce the cut quality and feed force. With sawblades with combinations of teeth the operator needs to ensure that at least one group of the teeth is permanently in the cut, otherwise the guidance between tool and work piece is lost and the cut quality deteriorates significantly.

Loose bushes to reduce the sawblade bore size are not permitted when mounting sawblades. The sawblade flange should be as big as possible to support the saw blade accurately and, for a good cut quality, the flange run out tolerances should not exceed 0.02 mm. The flange should be checked regularly for damage and run out. Also, the run out tolerance of the saw spindle should not exceed 0.02 mm.

On machines with a choice of spindle speeds, the speed should be selected to suit the workpiece material.



The **riving knife** is a “guiding system” and a feature of every table saw. The riving knife is mounted in a slot in the machine so that the height and angle can be adjusted to suit the position and diameter of the sawblade. The thickness of the riving knife has to match the thickness of the sawblade and cannot be thicker than the cutting width of the sawblade or thinner than the sawblade body. The distance between the sawblade and the riving knife should be less than 8 mm, and the upper edge of the riving knife should be about 2 mm below the highest saw tip.

6.1 Sawing machines

The **extraction** on a table saw removes the chips and dust generated by the sawblade from above and below. The saw guard/dust extraction hood cannot be fastened on the riving knife.

There are a number of steps to follow when mounting and adjusting a sawblade to prevent accidents.

Before starting the saw, the position of the riving knife and saw guard/dust extraction hood must be adjusted to match the sawblade. The saw guard is then adjusted to the workpiece thickness or lowered to the machine table.

The rip fence may only be moved towards the sawblade when the machine is not running. The fence has to be moved away to avoid clamping the workpiece. A push stick should always be used with narrow work pieces (120 mm and less). With very narrow workpieces (less than 30 mm wide) using a push stick plus the fence as a guide is the preferred method of operation.

To avoid double cutting and twisting when cross cutting workpieces between sawblades and fence it is necessary to allow space between fence and the sawblade. After cutting the workpiece should be moved away from the saw and the danger zone with a push stick. A riving knife must be used to prevent contact between the cut workpieces and the rising teeth of the sawblade. When cross cutting narrow workpieces the fence should be released after cutting and the workpieces removed from the sawblade from the side, or pushed through with a push stick.

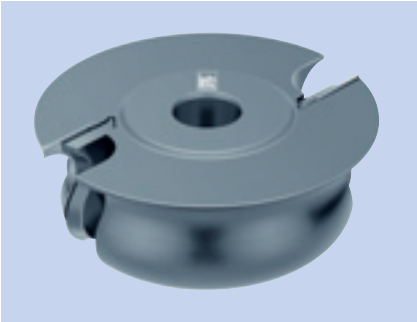
Device for insertion cutting.

With machines without hydraulic or electric sawblade height adjustment sawblade, certain devices have to be used to prevent kickback when machining a stepped cut. For producing stepped grooves the riving knife has to be removed. To secure the workpiece, the crosscut fence can be used as a kick-back securing device. The correct distance between sawblade and workpiece has to be adjusted. After this adjustment the workpiece is pushed against the kick-back device and pushed down to the machine table. The workpiece will be moved to the next stop which defines the length of the cut. After finishing the operation, the riving knife must be replaced.

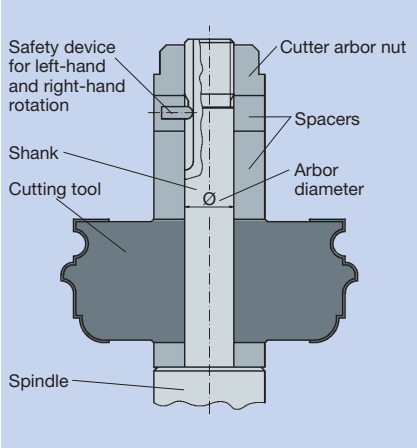
Device for blind cutting.

When cutting a groove the riving knife must be used and adjusted when the machine is not running. During grooving the workpiece has to be firmly pressed against the machine table whilst being pushed forward. With cutting a rebate the process steps should be ordered so the cut strips come out on the left side of the sawblade. This prevents clamping between fence and sawblade preventing the risk kickback. If, when rebating a conical work piece the cut strips fall on the right side of the sawblade, a push stick must be used to remove the pieces because of risk of kick back.

6.2 Spindle moulders



Leitz ProfilCut for manual feed in round shape – chip breaker integrated in clamping wedges.



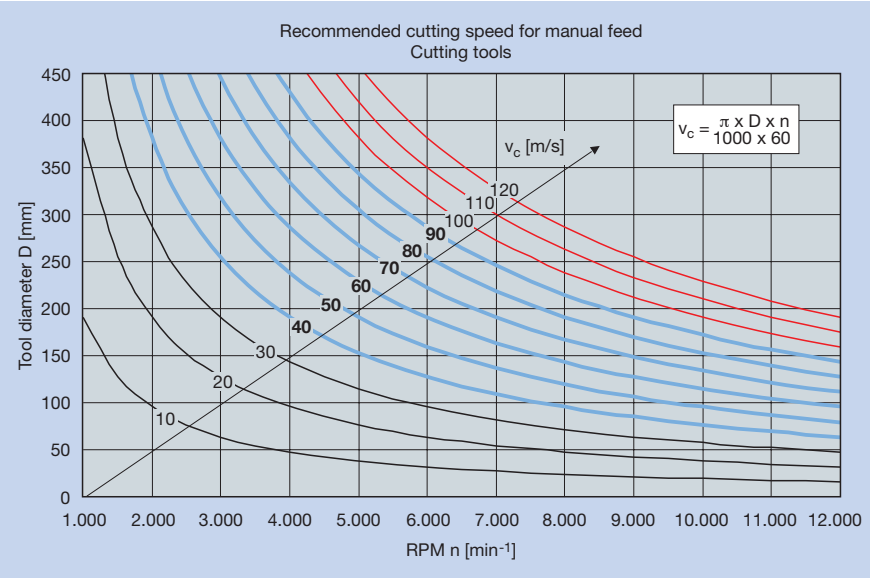
Moulder – cutting spindle with tool.

Well-equipped moulders.

Only tools with limiters should, in general, be used when working with hand feed machines. The chip thickness is limited by the small cutter projection. These tools are known as chip (thickness) limited cutting tools. Tools without chip limitation should only be used on machines with mechanical feed.

Before mounting a profiling tool on the machine spindle, you should check if the tool is suitable for hand feed, i.e. marked MAN or “BG-Test”. Also the speed range of the spindle has to be adjusted to suit and must not exceed the maximum rotational speed of the tool. The correct rotational direction, i.e. against feed, is very important. Pre-splitting when machining solid timber can be minimised by chosing the smallest possible tool diameter and/or a tooling system incorporating a chip breaker, for example Leitz ProfilCut. The workpiece should be machined against the direction of growth of the timber.

The tool and spacers must have clean damage free clamping surfaces. The spacers have to be chosen so the spindle nut thread is fully used. Before the spindle clamping nut is tightened, an anti-twist safety device should be added.



The chips and dust have to be extracted during the machining process. Pressure, protection and feeding devices are available as machine accessories. The cutting height and depth can be adjusted by moving the spindle and fence. The fence must be set as close to the rotating tool as possible and clamped tightly. The tool guard must protrude at least 15 mm past the tool cutting circle in the working area.

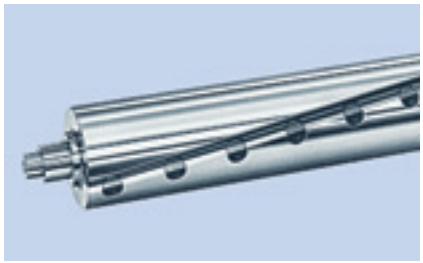
A continuous fence is used when machining the long edge to guide the workpiece accurately. When working across the end of the workpiece, clamping and feed devices are used. If hand fed, the workpiece is firmly guided by a pressure shoe that covers the tool. For stepped cuts an anti kick-back device must be used.

6.2 Spindle moulders

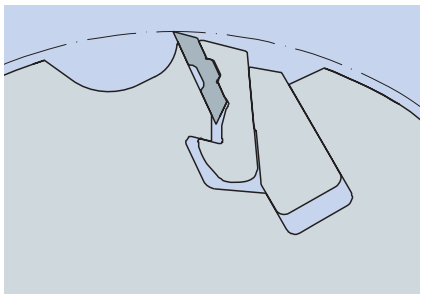
A ring fence or a guide ring mounted on the machine spindle is used when machining curved workpieces. The feed has to be even and when working against or across the grain the feed speed should be reduced to reduce the break out.

A ring fence or guide ring is also used with a jig for safe guidance of the workpiece. Small workpieces should use a double jig.

6.3 Surface planing and thickness machines



Leitz spiral cutter block.

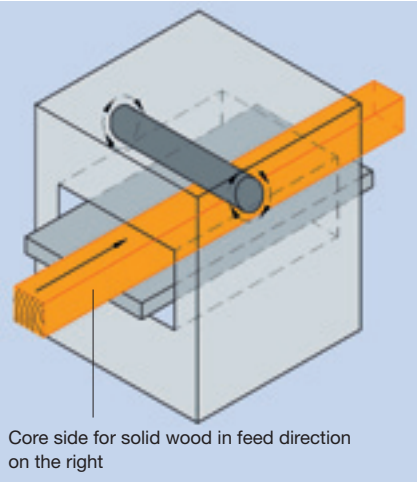


Principle of Leitz VariPlan-System with resharpenable knives and a steel tool body.

Surface planing and thickness machines are amongst the most used in woodworking. There are many designs of machining and the tooling technology used on them is as varied. Choosing the appropriate tooling system is based on the frequency of daily use.

Planing and thickness machines are noisy, but the noise level can be reduced when surface planing by machining the workpiece several times at a low cutting depth. Another proven, but relatively time consuming technique is to use spiral cutter blocks. If only needed occasionally, planerheads with planer knives are sufficient. Setting the planer blades to the same cutting circle with a setting gauge takes a long time and can prove uneconomical when there are frequent knife changes. Self-positioning knife-systems such as Leitz CentroStar with turnblade knives or Leitz VariPlan with resharpenable blades are recommended in these cases. Both planerhead systems are available with tungsten planer knives, which further improve the economies. It is important with all planing systems that the width of the planer blades matches the tool body or is the same width as the clamping wedge. Filler pieces can be used with short planer knives. On hand feed machines the planer blades are not allowed to project more than 1.1 mm out of the body. Kick back is the biggest risk with these machines and for this reason tools for planing and thickness planing machines are usually designed with circular tool bodies. Planer blades can project a maximum of 1.1 mm for a tool with 4 planer blades, or 3.0 mm for a closed body design tool with 2 blades. Because of the small planer blade projection, any resin build up should be removed regularly from the planer blades, clamping systems and tool body to ensure smooth operation.

6.3 Surface planing and thickness machines



Thicknessing machine.

The out-feed table on surface planing machines has to be adjusted carefully to match the tool diameter. Set too high results in a tapered workpiece, set too low forms a “step” at the end of the workpiece. Machines with rollers or rollers within the table should only be used for surfacing planing. When planing to an exact thickness the rollers should be lowered below the table level, otherwise the beginning and the end of the workpiece will have a different thickness. There is a high risk of injuries when machining short or thin workpieces and it is important to use the correct feeding equipment. As a rule the best results are achieved if when thicknessing the heartwood side is to the top right, and when surface planing it is on the operator side to the bottom left.

7. Machining with portable machines

7.1 Portable circular saw

Oscillating cover saw.

Dipping saw.

There are two types of portable circular saw:
a) Oscillating cover saws
b) Dipping saws.
The most popular are oscillating cover saws as they offer greater cutting depths. Oscillating cover saws have, as the name implies, an oscillating protection guard, which closes automatically after use.
Dipping saws have a one-piece, fixed protection cover, and the motor and sawblade unit swivels into the home position after use; the sawblade is enclosed by the protection guard.

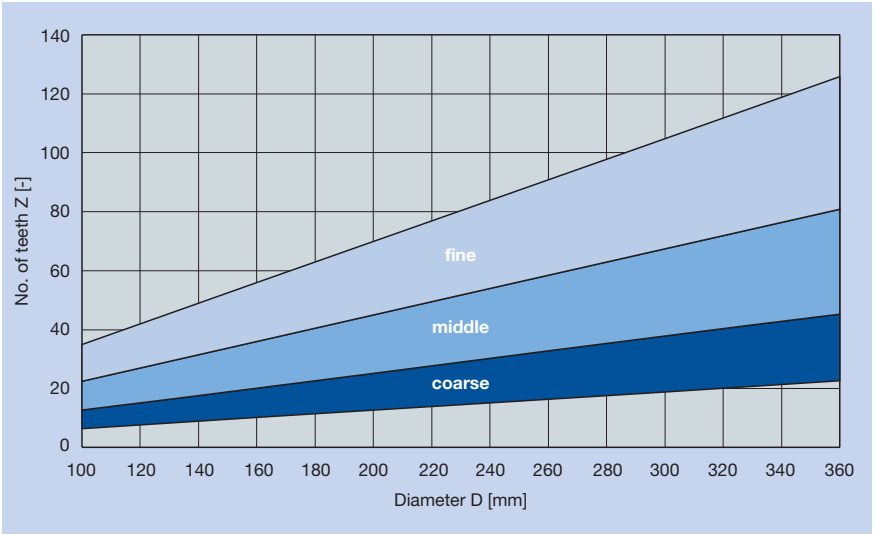
Dipping saws are suitable for plunge cuts. The riving knife is spring mounted on the latest dipping saws to make it swivel away when plunge cutting.
A range of stop and guide bar systems are available for portable circular saws to aid precise positioning. It is recommended always to use these other than when machining rough sizing cuts.
Dust extraction/collection devices should be used when using portable circular saws to minimise the operator's exposure to dust and to protect the workpiece surface from indentations from the chips.

The choice of the correct circular sawblade is set by the following criteria:
1. Material to be cut (solid wood, wood derived materials…)
2. Surface coating (veneer, plastics, HPL…)
3. Required cut quality (rough, medium or fine)
Additionally, with solid wood, whether cutting along the grain or across the grain.

For ideal tooth shape for each material, please see the attached table.

The right number of teeth is as important as the tooth shape for a satisfactory cut quality.

The ideal number of teeth for a desired cut quality is detailed in the chart and these can be regarded as bench marks. The higher the required cut quality, the greater the number of teeth required. Power consumption increases with the number of teeth and reduces the battery life of battery powered machines significantly.



7.1 Portable circular saw

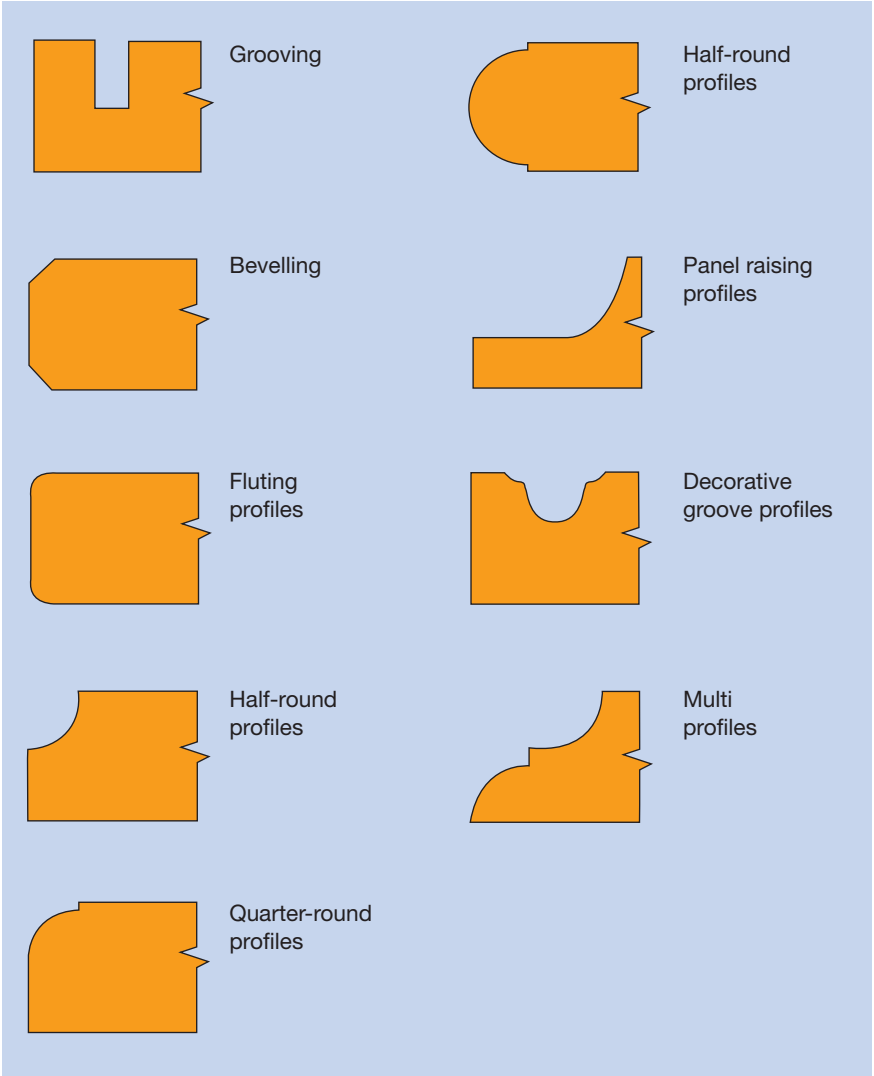
	Tooth shape	Application
	Square teeth	Solid wood, along and across grain
	Alternative top bevel teeth, positive	Solid wood along and across grain as well as glued Timber products uncoated, plastic coated, veneered Plywood, multiplex Compound materials Plywood
	Alternative top bevel teeth, negative	Solid wood across grain Plastic hollow-wall profiles Non-ferrous metals – extruded profiles and pipes
	Square/trapezoidal teeth, positive	Timber products without coating, plastic-coated, veneered Non-ferrous metals – extruded profiles and pipes Non-ferrous metals Al-PU sandwich panels, Plastic hollow-wall profiles Polymer plastics (Corian, Varicor, etc.)
	Square/trapezoidal teeth, negative	Non-ferrous metals – extruded profiles and pipes Plastic hollow-wall profiles Al-PU sandwich panels
	Inverted V/hollow teeth	Timber products plastic-coated and veneered coated profile strips (skirting board)
	Square teeth, bevelled	Construction saw machine

7.2 Portable routing machines

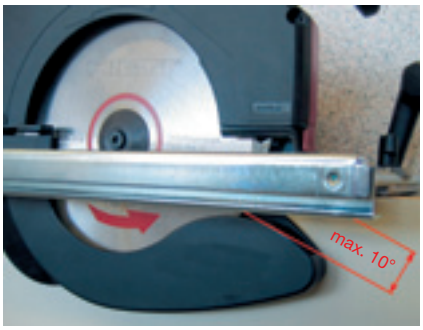
Portable routing machine.

Portable routers are multi-purpose machines with almost unlimited applications. Some of the most frequent applications are shown in the drawings below.

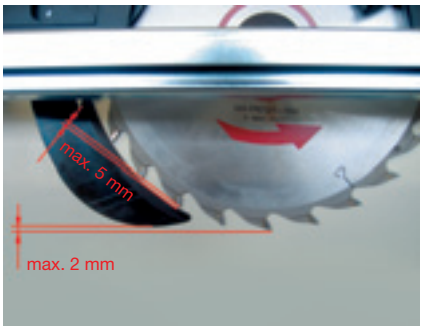
Many portable routing machine tools have ball bearing guide rings or guide pins to guide the tool accurately along the edge of the workpiece.
Another option is to use a template. The template, mounted on the machine table, means a small series of exact copies can be produced.
Panel sizing or grooving is best carried out with the aid of a stop or guide rail system. Circular pieces can be machined with a radius bar, similar to using a pair of compasses.
Portable routing machines are often used for flush-cutting veneers or plastic laminates glued to but projecting from the surface of pre-sized panels.
Here routing tools with ball bearing guide rings are used, the tool cutting circle diameter is the same as the ball bearing guide ring. Often it is not possible to fit an effective dust extraction system to a portable router because of the restricted space. Some machines do have an exhaust port useful when grooving.



7.3 Safe handling of portable circular saw machines
7.4 Safe handling of portable routing machines



Sawblade-protection cover.



Sawblade-riving knife.

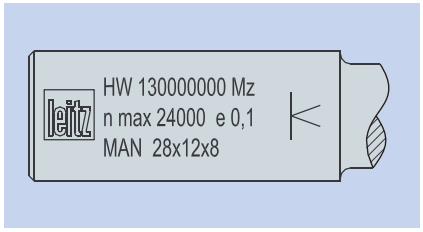
Handling portable circular saw machines is covered by special rules, in Germany as laid down by the Holz-BG (Wood-Employer's Liability Insurance Association).

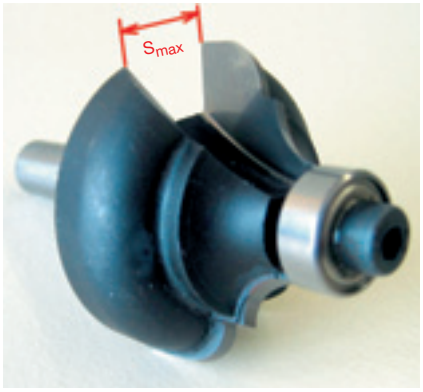
Portable circular saw machines have to comply with two main safety regulations:

1. The spring loaded guard has to cover the part of the sawblade protruding from the underside of the saw table both laterally and vertically except at the mouth where a maximum opening of 10° is permissible.

2. Portable circular saws must have a riving knife. The thickness of the riving knife must match the thickness of the sawblade and must not be thicker than the kerf of the sawblade or thinner than body of the sawblade. The gap between the riving knife and the sawblade must not be greater than 5 mm and the sawblade must not protrude more than 2 mm past the riving knife.

The maximum permitted sawblade RPM (as marked on the sawblade) must not be exceeded. The portable circular saw machine spindle RPM is detailed on the manufacturer's machine plate. If a portable circular saw machine is installed in a table as a stationary machine the regulations for table and sizing circular saw machines apply.





Cutting tool portable router.

Only tools for manual feed can be used on **portable routing machines**. Cutters with shanks with a cutting circle diameter of d = 16 mm or greater must be marked MAN.
The minimum shank clamping length has to be marked on the tool shank with an arrow. For safe tool clamping the routing tool must be inserted into the collet at least as far as this mark.

The maximum RPM n_{max} stated on the tool shank must not be exceeded. Portable routing machines are normally fitted with electronic RPM limiters. The machine manufacturers manuals detail the RPMs as specified by the regulations.

Manual feed routing tools with a cutting circle diameter of d ≥ 16 mm have to be designed as circular tools or equipped with limitors. EN 847-1 details the maximum permitted gullet width depending on the largest cutting circle diameter.
For cutting circle diameters of d = 70 mm the cutting edge must not protrude from the tool body by more than 1.1 mm.

8. Machining of non-wood based material

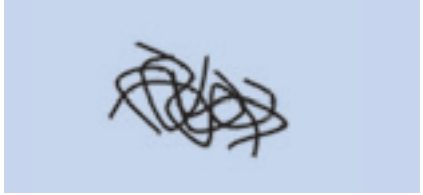
8.1 Plastics

A member of the Leitz-group

Plastics are all around us today. Different colours and shapes, soft or hard, inexpensive packaging material or even as strong components in air and space travel. There seems to be no limits to the possible applications for plastics. New plastic compounds and plastic composites continue to expand the breadth of possible applications. It appears no other material has the growth-potential of plastic.
Different plastics have different characteristics, and these characteristics have to be considered when machining plastic. Only tools specifically designed for that material, machining at the correct operating parameters, will give the best product quality, profitability and reliable production.
A common characteristic of all plastics is their low density and low heat conductivity. These so called monomers are the basis of plastics.
How the monomers are combined to form polymers determines the essential characteristic of the plastic.

Variety of plastic.

Extruded plastic profiles.



Structure of monomers.

Thermoplastics
Thermoplastics are mechanical composites of monomers – similar to wool. A typical characteristic of thermoplastics is that they have a temperature at which they soften. Once a thermoplastic is heated above this temperature it is soft and can be formed and shaped. Below this temperature (specific to a particular thermoplastic) thermoplastics stay in their original shape. Thermoplastics can be used in a number of processes – injection moulding, extrusion and presses.

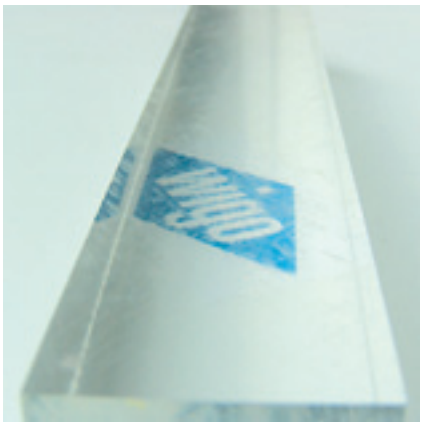
The temperature at which thermoplastic starts to soften is around 60' (depends on the specific plastic), a temperature corresponding to the machining process. Exceeding the softening temperature during machining is detrimental to the machined quality. The chips melt, the tools become sticky, and both quality and production are no longer consistent. As well as the special tooth geometries and tool chip gullets the machining parameters are very important.

Parameters for machining thermoplastics with Wigo tools are:

Process	Cutting speed	Feed per tooth
Sawing	50-65 m/s	0,05-0,1 mm
Milling	25-55 m/s	0,1-0,6 mm
Routing/Drilling	2-55 m/s	0,1-0,6 mm

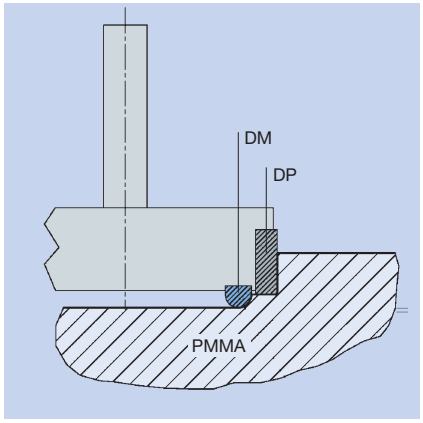
Plastic Profiles
Extruded plastic profiles, i.e. thermoplastics, are being made with thinner and thinner wall thickness. Mineral additives (fillers) make the material brittle and cracks can form when machined because of the high cutting force. The cutting force should be kept to a minimum. The tools and parameters must be designed to suit.

Process	Cutting speed	Feed per tooth
Sawing	55-70 m/s	0,01-0,05 mm
Milling	25-55 m/s	0,1-0,6 mm
Routing/Drilling	2-55 m/s	0,1-0,6 mm



Well sawn surface at PMMA.

Polish-cutted surface at PMMA.



Machining principle of polish-cutting – face milling 0.2-0.5 mm cutting depth.

Structure of duro plastics.

Transparent Thermoplastics

Transparent thermoplastics like PC and PMMA have an important role. Both trade and industry want a clear edge finish. It is possible to achieve a good finish quality with tungsten cutters, but it is important that, apart from cutter sharpness and tooth shape, there is lubrication, cooling and a stabile, flexible machine. The surface quality will not be acceptable without these.

If an opaque surface is acceptable tungsten or HSS tools can be used.

The machining parameters are:

Process	Cutting speed	Feed per tooth
Sawing	50-65 m/s	0,01-0,04 mm
Routing/Drilling	2-65 m/s	0,1-0,6 mm

Diamond tipped routers or natural diamond milling cutters will give a polished finish.

Process	Cutting speed	Feed per tooth
Routing	10-15 m/s	0,1-0,5 mm
Edge Milling	10-15 m/s	0,02-0,03 mm

Sawblades with a flat/triple chip tooth configuration are recommended for cutting tough thermoplastic materials. For hard or thin walled plastics, sawblades with an alternate top bevel tooth give a better result.

Thermosetting polymers

The monomer link in cured plastics is based on a chemical bond. A net is a good visual model of the structure. When a cured plastic is heated, the monomers start to move and the vibrations increase with rising temperature. If the material specific temperature is exceeded, the nodal connections are irretrievably broken. As a result the cured plastic is destroyed at a temperature specific to the material – the “pyrolysis temperature” – usually above 150°C. Cured plastic materials are usually either cast or pressed with compounds, and as a rule hard and brittle. Cured plastics have the following cutting parameters.

Process	Cutting speed	Feed per tooth
Sawing	60-70 m/s	0,01-0,08 mm
Milling	45-65 m/s	0,1-0,6 mm
Routing/Drilling	2-65 m/s	0,01-0,6 mm

Temperature is not critical in the cutting process. Tools machining cured plastics must, compared to tools for thermoplastics, have different parameters and different technical geometry and cutting materials specifications.

8.1 Plastics

Reinforced duro plastics.

Added reinforcements improve the properties of cured plastics – cardboard, glass fibre, carbon fibre, Aramid fibre. The different combinations of these materials have names like FR2, FR3, FR4, CEM1, CEM 3... (FR4 for example stands for epoxy resin with glass fibre).

The cutting parameters are adjusted to suit the fibre content

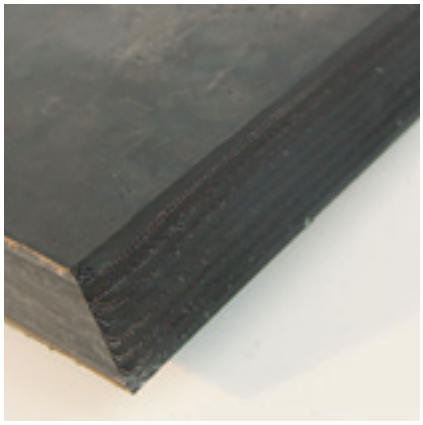
Process	Cutting speed	Feed per tooth
Sawing	40-70 m/s	0,01-0,8 mm
Milling	40-65 m/s	0,05-0,6 mm
Routing/Drilling	2-65 m/s	0,01-0,6 mm

HPL-parts.

Thin board materials, like FR4, coated with copper form the laminate for printed circuit boards. The addition of the copper changes the cutting parameters.

Process	Cutting speed	Feed per tooth
Sawing	47-65 m/s	0,01-0,03 mm
Milling	45-55 m/s	0,05-0,1 mm

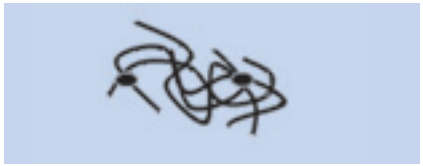
HPL (High Pressure Laminate)
HPL materials are layers of paper impregnated with synthetic resins bonded at high pressure and temperature. When machined this hard, high-density material, results in high cutting forces. Diamond, is an economic cutting material though tungsten is an alternative for small batches. The tooth feed rate and any machine vibrations are visible on the cut surface. Low-vibration AS-foil sawblades improve the cut quality.



Cutting quality elastomere.

Process	Cutting speed	Feed per tooth
Sawing	50-70 m/s	0,01-0,08 mm
Milling	50-60 m/s	0,03-0,1 mm
Routing/Drilling	2-60 m/s	0,03-0,1 mm

Elastomers
Elastomers are soft plastics. Materials known as rubber belongs to the elastomers group. Here the monomers are linked in a combination of chemical and mechanical bonding. The structure is like a wide-meshed net. It is possible to machine, but the difficulty lies in clamping the work pieces. The cutting parameters for elastomers are detailed below.



Structure of elastomere.

Process	Cutting speed	Feed per tooth
Sawing	50-65 m/s	0,01-0,03 mm
Milling	30-50 m/s	0,04-0,06 mm
Routing/Drilling	2-50 m/s	0,01-0,06 mm

8.2 Mineral materials

Board materials are formed from mineral particles are bonded with a binder. The specific material properties depend on the proportion and type of binder.

Corian-panel on sizing saw.

Plastic bonded mineral materials
(Corian, Kerrock, Noblan, Surell, Varicor)
These are two-thirds natural mineral (aluminium hydroxide) and one-third Acrylic resin (PC). The material can be formed when heated because of the high proportion of acrylic. The mineral particles raise the softening tempe-rature and make it easier to work the material. The high proportion of artificial materials reduces the tool wear. Vibration reduced AS-foil saw-blades are recommended because the material has a relatively high density. These saws improve both the cut quality and run time. Either tungsten or diamond can be used, it depends on the quantity.

Process	Cutting speed	Feed per tooth
Sawing	50-70 m/s	0,02-0,04 mm
Milling	40-55 m/s	0,4-0,8 mm
Routing/Drilling	2-55 m/s	0,4-0,8 mm

Cutting area of perlite panel.

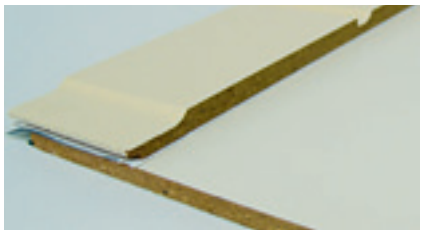
Fire protection boards on a Perlite basis
These materials are characterised by their highly abrasive effect on the tool body, a particular problem with sawblades with thin sawblade bodies.
The gullet is eroded and weakened, and as the cutting forces cannot be absorbed the tooth becomes loose, even though the tungsten tip has yet to reach the end of its life. The risk of accidents increases and production reduces. These problems can be reduced by using gullet protected tools and tool designed specifically to cut these materials.

Process	Cutting speed	Feed per tooth
Sawing	40-60 m/s	0,05-0,2 mm
Milling	25-40 m/s	0,2-0,7 mm
Routing/Drilling	2-40 m/s	0,2-0,8 mm

Gypsum plasterboard- and gypsum fibreboard.

Gypsum fibreboard, Gypsum plasterboard
These materials are machined either in a dry or wet state. Tungsten is re-commended for cutting in the wet state. Sawblades with special symmetrical tooth shapes are best. Diamond is better when cutting dry materials.
As with many mineral materials low cutting speed and relatively high feed speeds are desirable.

Process	Cutting speed	Feed per tooth
Sawing	40-65 m/s	0,05-0,2 mm
Milling	25-40 m/s	0,2-0,8 mm
Routing/Drilling	2-40 m/s	0,2-0,8 mm

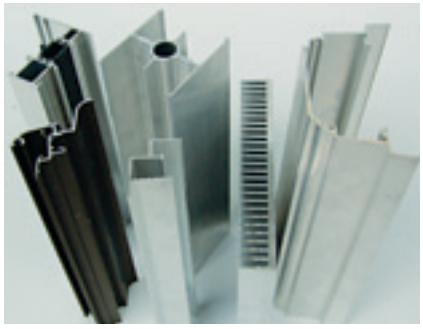


Veneered profiled cement fibre boards.

Cement fibreboard

Cement fibreboards are characterised by their high density. The incorrect machining parameters can cause sparks during machining. Since tungsten has a low run time diamond is recommended for cutting these high quality materials.

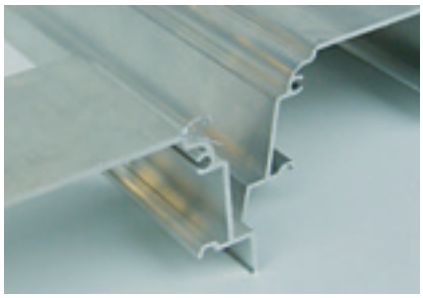
Process	Cutting speed	Feed per tooth
Sawing	35 m/s	0,01-0,03 mm
Milling	35 m/s	0,2-0,5 mm
Routing/Drilling	2-35 m/s	0,05-0,4 mm



Aluminium extruding machine profiles.

Non-ferrous metals

Aluminium can be divided into three different groups, pure aluminium, aluminium alloys and cast alloys. Aluminium profiles and rolled aluminium materials are usually aluminium alloys. Apart from the cutting parameters it is important to choose the correct cutting material and tool geometry. Cooling and lubrication are necessary when cutting with tungsten. Noise reduced AS-foil sawblades improve the cut quality. Sawblades with tooth shapes to produce small chips help chip removal. This is important for reliable production.



Profile with and without burr.

Machining Aluminium profiles

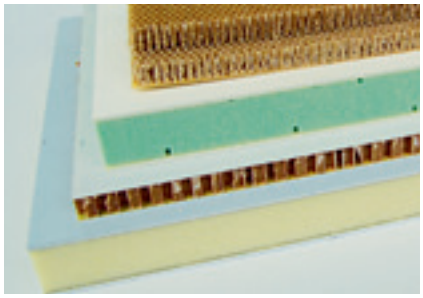
Process	Cutting speed	Feed per tooth
Sawing	55-70 m/s	0,01-0,05 mm
Milling	25-50 m/s	0,08-0,15 mm
Routing/Drilling	2-50 m/s	0,08-0,2 mm

Machining Pure Aluminium

Process	Cutting speed	Feed per tooth
Sawing	50-70 m/s	0,02-0,04 mm
Milling	30-50 m/s	0,2 mm
Routing/Drilling	2-50 m/s	0,2 mm

Machining Aluminium cast alloys

Process	Cutting speed	Feed per tooth
Sawing	20-30 m/s	0,02-0,06 mm
Milling	10-25 m/s	0,05-0,15 mm
Routing/Drilling	2-25 m/s	0,05-0,15 mm



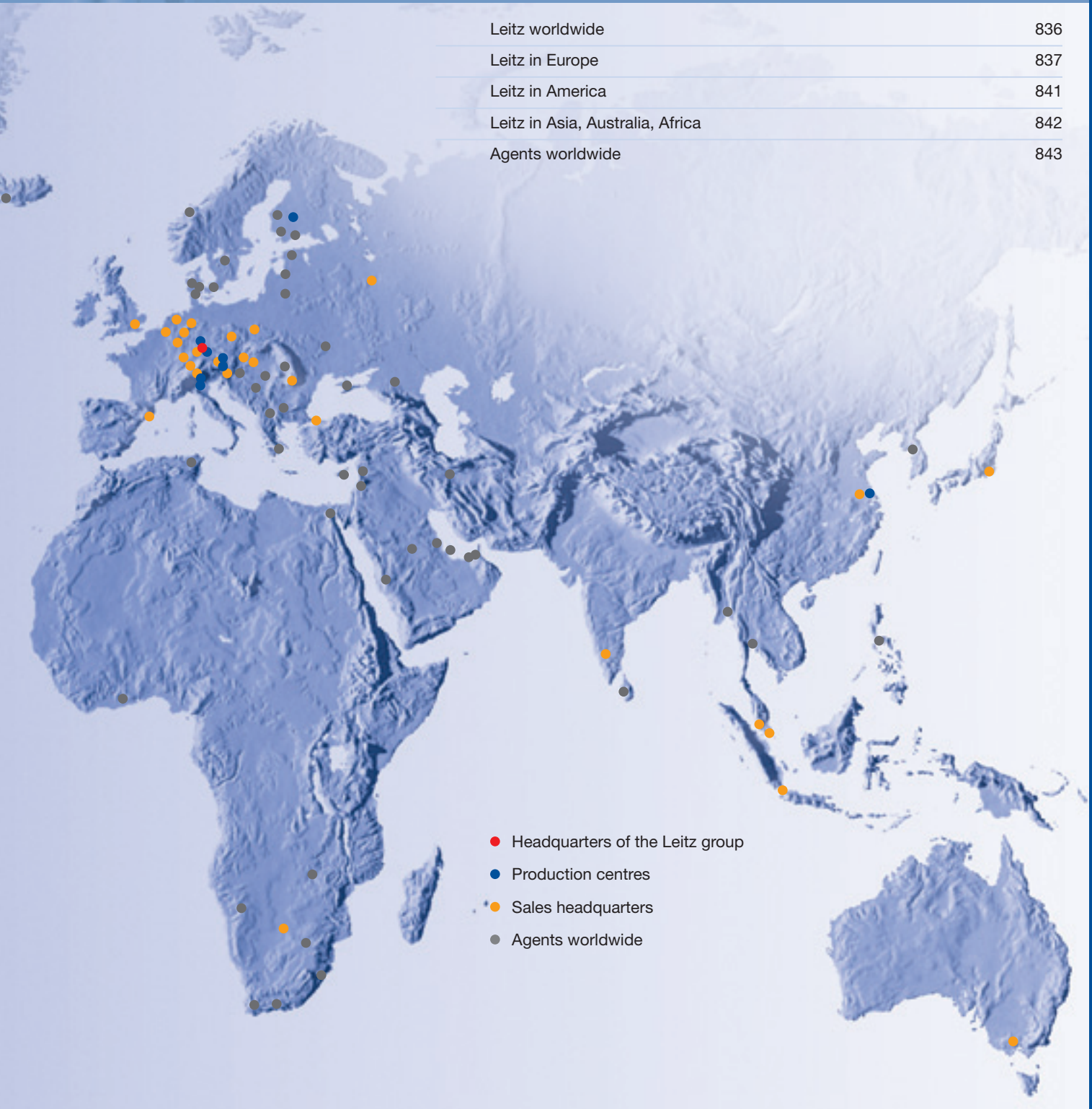
Light construction materials.

Special and Composite materials

Industry's demands for materials with improved properties have caused many changes in terms special and composite materials.
As we have the experience and the facilities to simulate the machining processes in our R&D department, we can design tools to suit the many different materials and material combinations.
It was through our R&D facilities we developed tooling programs for honeycomb board and foam materials combined with steel or aluminium sheets.

Leitz worldwide

Leitz worldwide	836
Leitz in Europe	837
Leitz in America	841
Leitz in Asia, Australia, Africa	842
Agents worldwide	843



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